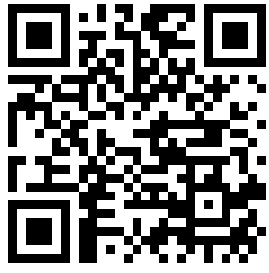
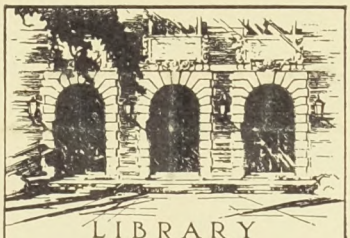


U. S.--BUREAU OF AERONAUTICS (NAVY DEPT)

INSTALLATION PRACTICES FOR AIRCRAFT ELECTRIC AND ELECTRONIC WIRING



(NAVY) NAVAER 01-1A-505
(USAF) T. O. 1-1A-14

Handbook

Installation Practices

For

Aircraft Electric And Electronic Wiring

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE
AND THE CHIEF OF THE BUREAU OF AERONAUTICS

(NAVY) NAVAER 01-1A-505
(USAF) T. O. 1-1A-14

Handbook

Installation Practices

For

Aircraft Electric And Electronic Wiring

PUBLISHED UNDER AUTHORITY OF THE SECRETARY OF THE AIR FORCE
AND THE CHIEF OF THE BUREAU OF AERONAUTICS

1 SEPTEMBER 1956

LIST OF REVISED PAGES ISSUED

INSERT LATEST REVISED PAGES. DESTROY SUPERSEDED PAGES.

NOTE: The portion of the text affected by the current revision is indicated by a vertical line in the outer margins of the page.

* The asterisk indicates pages revised, added or deleted by the current revision.

ADDITIONAL COPIES OF THIS PUBLICATION MAY BE OBTAINED AS FOLLOWS:

BuAer

USAF ACTIVITIES.—In accordance with Technical Order No. 00-5-2.

NAVY ACTIVITIES.—Use Publications and Forms Order Blank (NavAer 140) and submit in accordance with instruction listed thereon.

For listing of available material and details of distribution see Naval Aeronautics Publications Index NavAer 00-500.

TABLE OF CONTENTS

SECTION I

INTRODUCTION

1–1. GENERAL.

1–2. This is one of a series of handbooks prepared to assist military personnel engaged in the general maintenance and repair of aircraft. The area covered by this handbook is that of the aircraft electric system.

1–3. The satisfactory performance of present-day aircraft depends to a very great extent on the continuing reliability of its electric system. Improperly or carelessly installed wiring can be a source of both immediate and potential danger, and many malfunctions and failures of the electric system can be traced to this cause. The performance of the system depends on the quality of the design, plus the workmanship used in making the installation. The continued proper performance of the system depends on the "know-how" of the men who do the inspection, repair and maintenance.

1–4. It is highly important therefore that maintenance and repair operations, as well as the original installation, be made in accordance with the best available techniques in order to eliminate possible failures or at least to minimize them.

1–5. PURPOSE OF HANDBOOK

1–6. The purposes for which this handbook was written are as follows:

a. To gather together under one cover the recommended practices and techniques to be used for installing, repairing and maintaining aircraft electric wiring.

b. To standardize these techniques and methods so that electrical installations will be done in a uniform manner.

c. To indoctrinate all personnel with the importance of good workmanship.

d. To point up the failures which may result from poor workmanship.

e. To promote safety by pointing out and prohibiting unsafe practices.

1–7. SOURCE OF INFORMATION.

1–8. The information contained in this handbook represents the best current knowledge and practice in the aircraft electrical field. It has been compiled with the cooperation and assistance of the country's leading airframe manufacturers, airline operators and military overhaul and repair bases. Many of the illustrations have been provided by the manufacturers of electrical accessories used in aircraft.

1–9. SCOPE.

1–10. This handbook covers all general purpose wiring and wiring devices in aircraft used for the interconnection of equipment. It also includes thermo couple systems and coaxial cabling.

1–11. The handbook is not concerned in any way with design problems, or with the selection of wire, cable, connections, etc. However, in some cases, materials are noted as meeting specific temperature or environmental requirements.

1–12. INTENDED USE.

1–13. This handbook is intended primarily for the use of personnel engaged in maintenance and repair under government contract or at military bases. Its use is mandatory for such personnel, except where any procedure contained in it conflicts with any government specification or document, in which case the Government specification or document shall prevail and a report describing the conflict shall be submitted. The handbook will also be available to contractors as a guide and as recommended practice, but its use is not mandatory to these contractors. However, the practices used by the contractor will always be compatible with those of this publication so that modern techniques may be used to maintain the aircraft regardless of the manufacturer.

1–14. All the procedures described in this handbook are compatible with those currently used by airframe manufacturers. Repair and maintenance accomplished in accordance with this book should result in a quality equivalent to that in the original installation.

1–15. For specific installations, this handbook is intended to be used in conjunction with the applicable Handbook of Maintenance Instructions. Copies of Government Specifications and other official documents referenced herein, and the Index of Military Aeronautical (AN or MIL) Standards may be obtained upon application to the Commanding General, Air Material Command, Wright-Patterson Air Force Base, Dayton, Ohio, or the Commanding Officer, Naval Aviation Supply Depot, Philadelphia 11, Pennsylvania, Attention – Code ODPT.

1–16. ARRANGEMENT OF MATERIAL.

1–17. The material comprising the handbook is divided into sections. Each section describes and illustrates the recommended procedure for a single operation, or for a series of related operations.

1–18. The first five sections contain procedures for preparing and identifying wire, and for assembling it to connectors, terminals and splices. Later sections deal with procedures for thermocouple wiring, bonding and grounding, routing and support of wire bundles, and preparation and installation of conduit, buses, terminal blocks, junction boxes and protective devices. Directions for emergency repairs are found in the final section.

1–19. The material in each section is arranged as far as possible, in the general order in which the operations are performed. Illustrations and tables are located as near as possible to the related text. Each section is headed by an introduction containing a short description of the subject and its function in the aircraft electrical system. Where necessary for clarity, a list of definitions is included.

1–20. Also included in the introduction of the section is a listing of applicable Government specifications for the various materials required and design procedures on which these installation techniques are based.

1–21. REVISIONS.

1–22. Revisions and additions will be made from time to time to insure that the material in the handbook will always reflect the best current techniques, and keep abreast of the new developments in the field. Suggestions for correcting and improving this handbook are invited and should be sent to:

Chief, Bureau of Aeronautics, Department of the Navy,
Washington 25, D.C.

or

Commanding General,
Wright Air Development Center,
Wright-Patterson Air Force Base, Dayton, Ohio

SECTION II

WIRE AND CABLE PREPARATION

2–1. INTRODUCTION.

2–2. GENERAL. In order to make installation, maintenance and repair easier, runs of electric wire and cable in aircraft are broken at specified locations by junctions such as connectors, terminal blocks, buses, etc. Before assembly to these junctions, wires and cables must be cut to length, identified, stripped and if required, tinned.

2–3. SCOPE. This section describes and illustrates the recommended procedures for preparing wire and cable for attachment to junctions, and also describes some procedures for terminating shielded cable.

2–4. DEFINITIONS.

a. Wire. For purposes of electric or electronic installations a wire is described as a stranded conductor, covered with an insulating material. See Figure 2–1 for illustrations of wires commonly used in aircraft.

b. Cable. See Figure 2–2. The term cable, as used in aircraft electrical installations includes the following:

1. Two or more insulated conductors contained in the same jacket (multi-conductor cable).
2. Two or more insulated conductors twisted together (twisted pair).
3. One or more insulated conductors, covered with a metallic braided shield, (shielded cable).
4. A single insulated center conductor with a metallic braided outer conductor, (RF cable). The concentricity of center conductor and outer conductor is carefully controlled during manufacture to insure that they are coaxial.

NOTE

Instructions for RF cable are in Section IV.

c. Soft Solder. For use in aircraft electrical installations, soft solder is a mixture of 60% tin and 40% lead, as described in Federal Specification QQ-S-571. It may be in bar form to be melted for tinning, or in the form of rosin core wire solder for use with soldering iron.

d. Flux. For use with soft solder, flux is water-white rosin, dissolved to paste-like consistency in denatured alcohol.

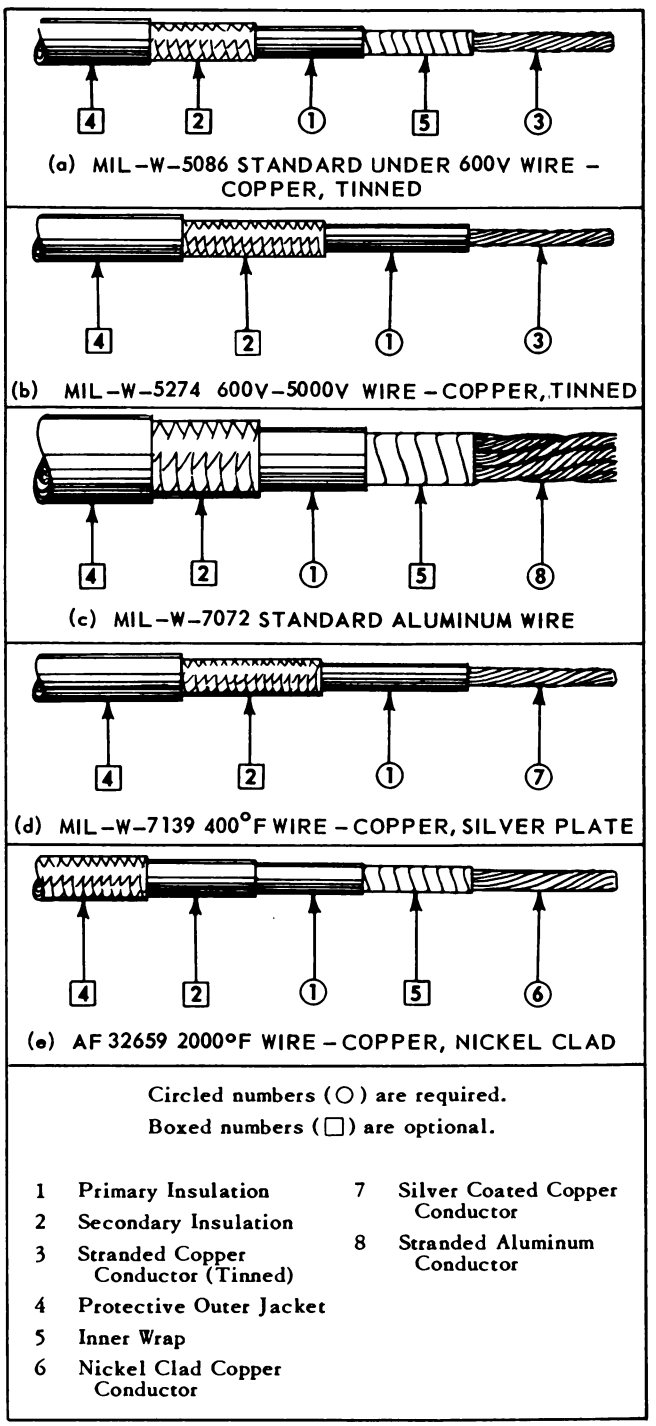


Figure 2–1. Wires Commonly Used in Aircraft

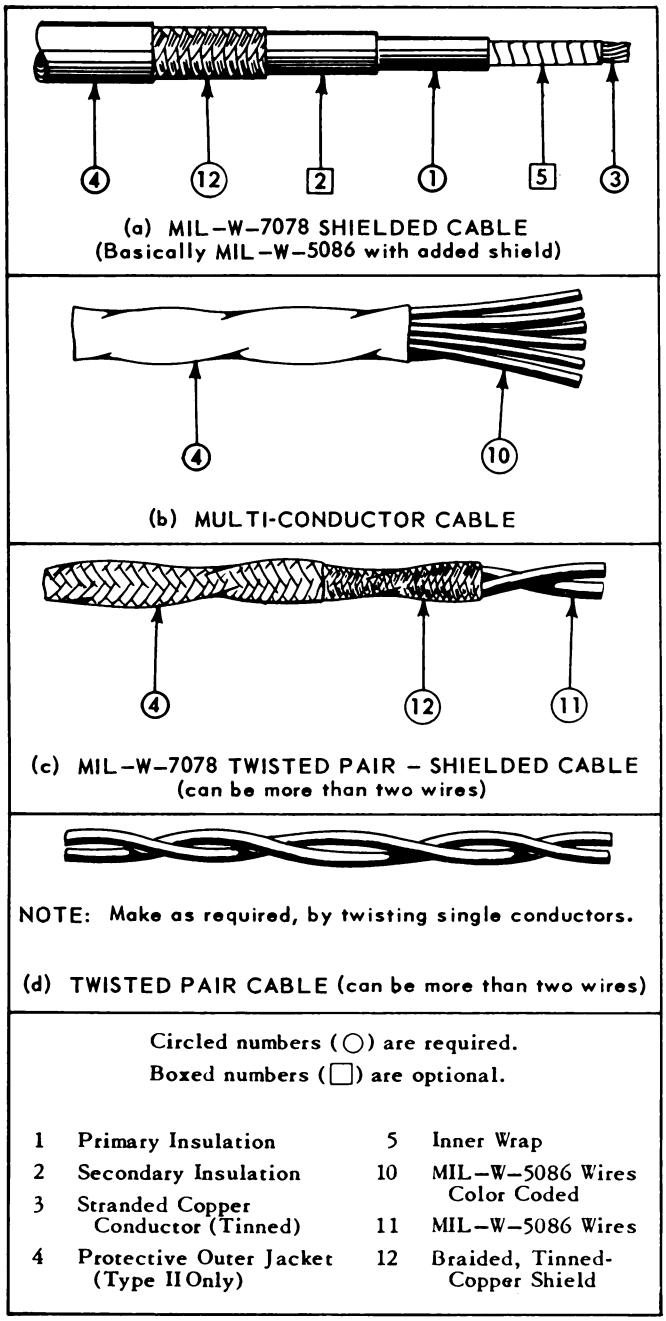


Figure 2–2. Cables Commonly Used in Aircraft

2–5. REFERENCE SPECIFICATIONS.

QQ–S–561	Solder, Silver
QQ–S–571	Solder; Soft (Tin, Tin-Lead, and Lead-Silver)
MIL–I–631	Insulation, Electrical, Synthetic-resin Composition, Nonrigid
MIL–C–1140	Glass Fiber; Yarn, Cordage, Sleeving, Cloth and Tape
MIL–I–3158	Insulation Tape, Electrical Glass-Fiber (Resin Filled); and Cord, Fibrous-Glass
MIL–I–3190	Insulation, Electrical, Sleeving, Flexible, Treated
MIL–M–4528	Marking Machine, Wire and Plastic Tubing, Identification
MIL–W–5086	Wire, Electrical, 600-volt, Copper, Aircraft
MIL–W–5274	Wire, Electrical, Insulated, Aircraft
MIL–A–6091	Alcohol; Ethyl, Specially Denatured, Aircraft
MIL–S–6872	Soldering Process, General Specifications for
MIL–W–7072	Wire, Electrical, 600 volts, Aluminum
MIL–C–7078	Cable, Power, Electrical, 600 volts, Shielded
MIL–W–7139	Wire, Electrical, Copper, Insulated, 600 volts, 400 degrees F.
MIL–I–7444	Insulation Sleeving, Electrical, Flexible
JAN–T–713	Twine, Lacing and Tying, Electrical and Electronic Equipment
AF 3269	Cable, Electrical, High Temperature and Fire Resistant

2–6. CUTTING WIRE AND CABLE.

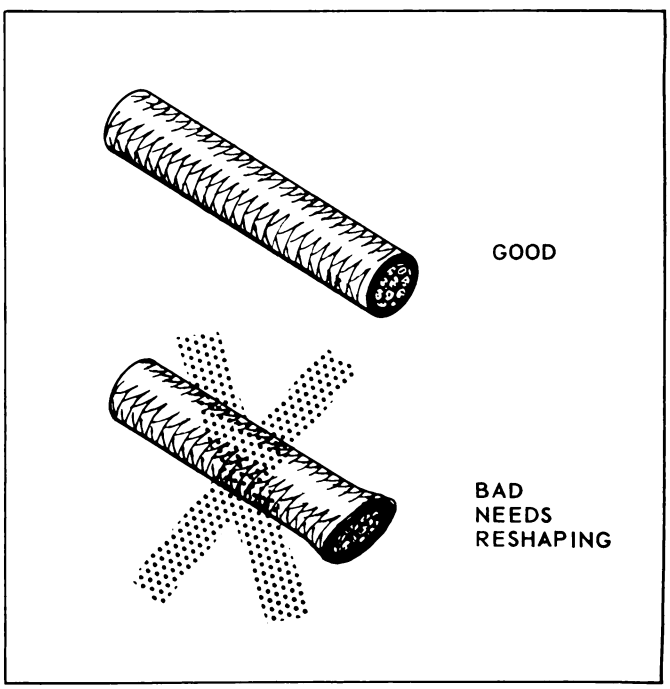


Figure 2–3. Wires After Cutting

2–7. GENERAL. Cut all wires and cables to lengths given on drawings or wiring diagrams. Cut wire and cable so that cut is clean and square and wire is not deformed. See Figure 2–3. After cutting reshape large diameter wire with pliers, if necessary.

CAUTION

Make sure that blades of cutting tools are sharp and free from nicks. A dull blade will deform and extrude wire ends.

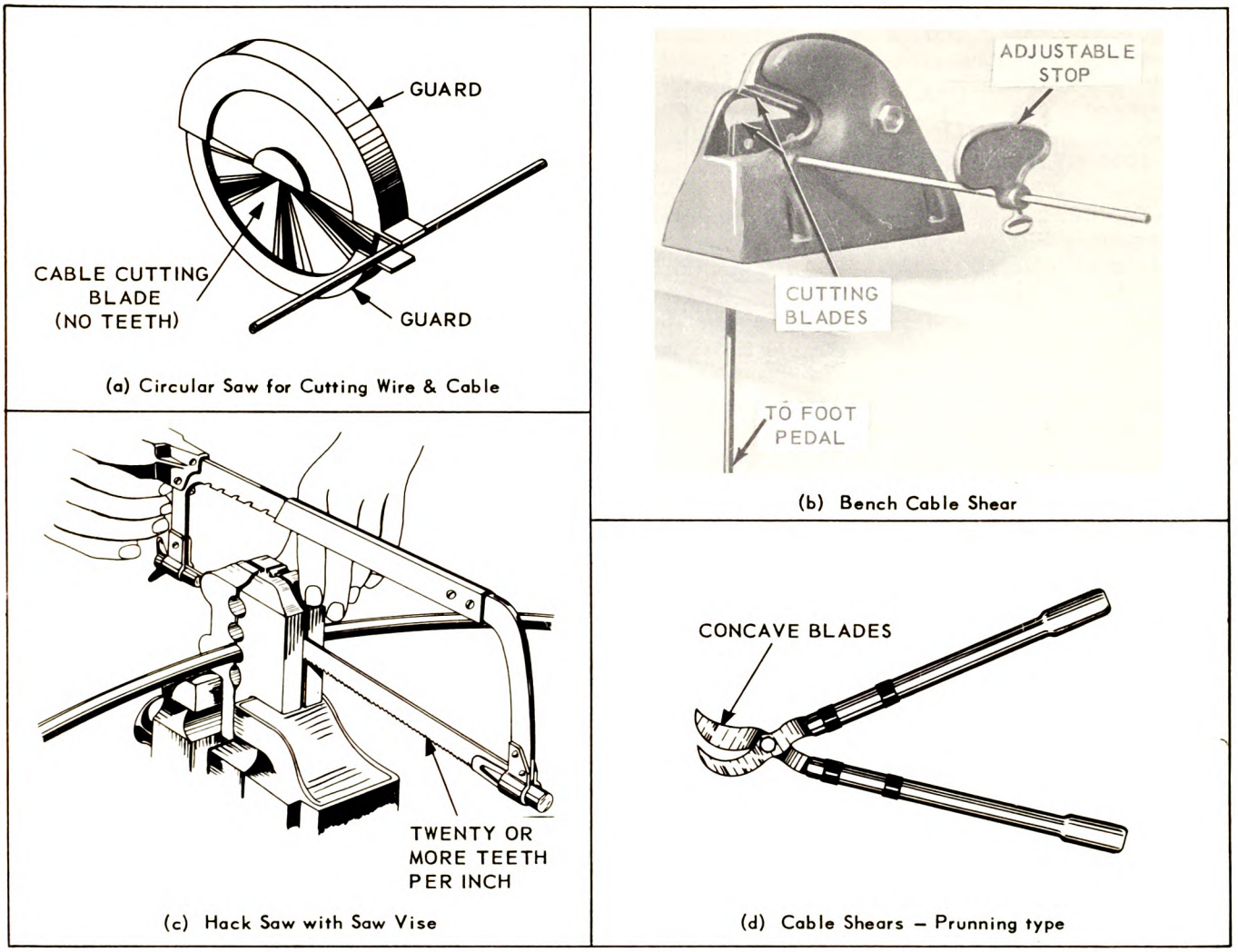


Figure 2–4. Wire Cutting Tools

2–8. CUTTING COPPER WIRE AND CABLE. To cut a large quantity of heavy wires or cables, you will find it convenient to use a circular saw with a cable cutting blade. A cable cutting blade is similar to a meat slicing blade (no teeth). See Figure 2–4a.

WARNING

Do not use a circular saw without an adequate guard over the blade.

Heavy or light copper wires can also be cut with bench shears such as shown in Figure 2–4b.

2–9. To cut a few heavy guage copper wires or cables use a fine tooth hack saw. A fine tooth hack saw has 20 or more teeth per inch. See Figure 2–4c for use of hack saw and saw vise which protects heavy wire during cutting.

2–10. To cut a few light guage copper wires, use diagonal pliers. Do not attempt to cut wires larger than AN-8 with diagonal pliers.

2–11. CUTTING ALUMINUM WIRE. Be careful when cutting aluminum wire to avoid deforming the conductors. Aluminum is more brittle than copper, and if deformed, aluminum wire should be reshaped carefully.

CAUTION

Never cut aluminum wire with tools which have reciprocating motion, such as a hack saw. Reciprocating cutting action "work hardens" aluminum. This will lead to broken and torn strands.

2–12. To cut a large number of aluminum wires use a power circular saw with cable cutting blade as shown in Figure 2–4a. Do not use toothed blade for cutting aluminum wire.

CAUTION

If cutting tool has been used for other metals, wipe blades clean before cutting aluminum. Copper or steel chips will cause aluminum to corrode.

Special cable shears with concave cutting edges such as pruning or dehorning shears may also be safely used to cut aluminum wire. A cable shear of this type is illustrated in Figure 2–4d.

2–13. IDENTIFYING WIRE AND CABLE.

2–14. GENERAL. To make maintenance easier, each interconnecting wire and cable installed in aircraft is marked with a combination of letters and numbers which identify the wire, the circuit it belongs to, its gage size and other information necessary to relate the wire to a wiring diagram. This marking is called the cable identification code. Details of the code are specified in MIL–W–5088. Some general information is given in the following paragraphs.

2–15. WIRE IDENTIFICATION CODE – BASIC. See Figure 2–5a. The basic wire identification code used for all circuits except those having the circuit function letters R, S, T or Y is as follows, reading from left to right:

a. Unit Number – Prefixed where necessary to distinguish between wires in a circuit having identical items of equipment and identification numbers.

b. Circuit Function Letter. Used to identify the function of the particular circuit. See MIL–W–5088 for details.

c. Wire number. Used to distinguish between wires with the same circuit function letter.

d. Wire segment letter. Used to distinguish between conductor segments in a particular circuit.

e. Wire size number. Used to designate AN or AL gage size of the wire. Wire size is omitted on coaxial cable. Wire size number is replaced with a dash for thermocouple wire.

f. Ground, phase or thermocouple letter. Used to denote a wire to ground, phase of a wire in a three-phase system, or materials of a thermocouple pair.

2–16. WIRE IDENTIFICATION CODE (R, S and T CIRCUITS). See Figure 2–5b. The identification code for circuits R, S and T, (Radio, Radar & Special Electronic circuits), in addition to the basic numbers and letters listed in paragraph 2–12, includes another letter after the circuit function letter, called the circuit designation letter, which further identifies the circuit inside the system. See MIL–W–5088 for details.

2–17. WIRE IDENTIFICATION CODE–(Y CIRCUIT). See Figure 2–5c. When the circuit function letter is Y, (indicating a special armament system), the basic code with the addition of a circuit designation letter is used, plus the number of the particular armament system, inserted after the circuit function letter. See MIL–W–5088 for details.

2–18. IDENTIFICATION METHODS. The preferred method of identification is to stamp the identification

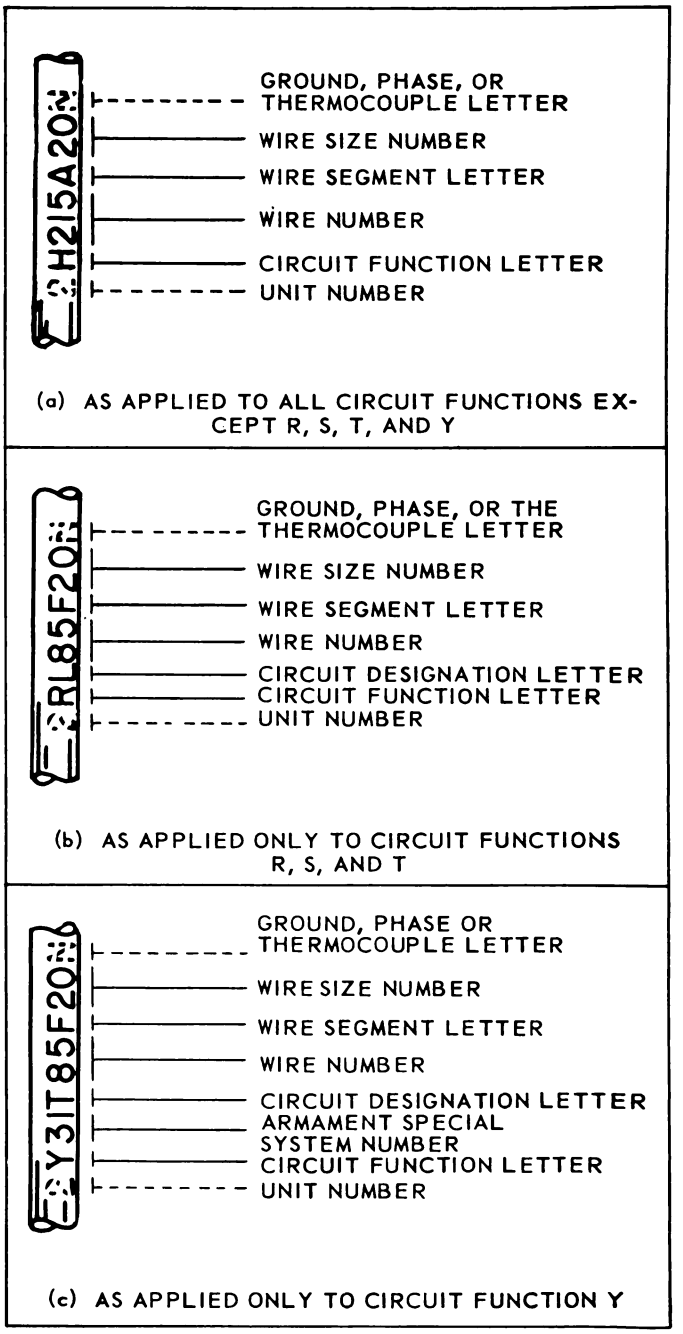


Figure 2–5. Examples of Wire Identification Coding

marking directly on the wire or cable with a hot foil stamping machine. Use this method wherever possible. If the wire insulation or outer covering will not stamp easily, lengths of insulating tubing (sleeves) are stamped with the identification marking and installed on the wire or cable. The following types of wire are usually identified by means of sleeves:

a. Unjacketed shielded wire
b. Thermocouple wires
c. Multiconductor cable
d. High temperature wire with insulation difficult to mark, (such as asbestos, teflon, fiberglass, etc).

CAUTION

Do not use metallic markers or bands for identification. Do not use any method of marking that will damage or deform the wire or cable.

Only use sleeves if wire cannot be marked directly. With care some wires, previously thought to be unsuitable for direct marking, can be stamped with a standard marking machine using special foils.

2–19. MARKING OBJECTIVES. Whatever method of marking is used, be sure marking is legible, and that color of stamping contrasts with the wire insulation or sleeve. Use black stamping for light colored backgrounds. Use white on dark colored backgrounds. Make sure that markings are dry so they do not smear.

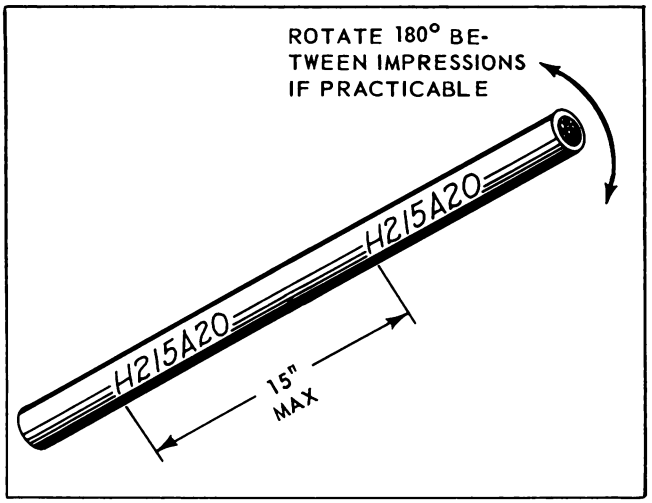


Figure 2–6. Spacing of Identification Stamping on Wire and Cable

2–20. SPACING OF STAMPED MARKS. See Figure 2–6. Stamp wires and cables at intervals of not more than 15 inches along their entire lengths. In addition stamp wires within three inches of each junction (except permanent splices), and at each terminating point. Stamp wires which are three to seven inches long in the center. Wires less than three inches long need not be stamped.

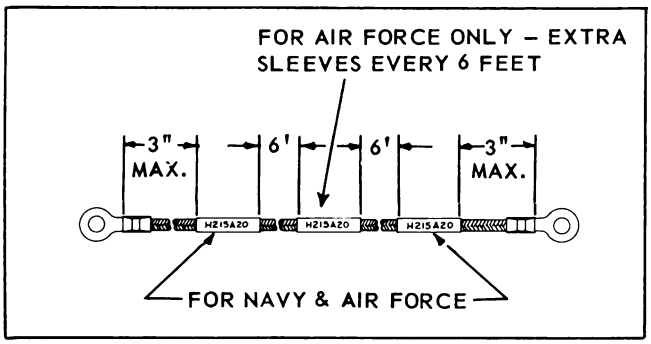


Figure 2–7. Location of Identification Sleeves

2–21. LOCATION OF SLEEVE MARKING. See Figure 2–7. When wire or cable cannot be stamped directly, install a plastic sleeve marked with the identification number over the outer covering at each terminating end. For Air Force planes, also install marked sleeves at not more than six foot intervals on the entire length of such wire or cable.

CAUTION

Do not use sleeves to change identification of wire or cable which has already been marked, except in the case of spare wires in potted connectors.

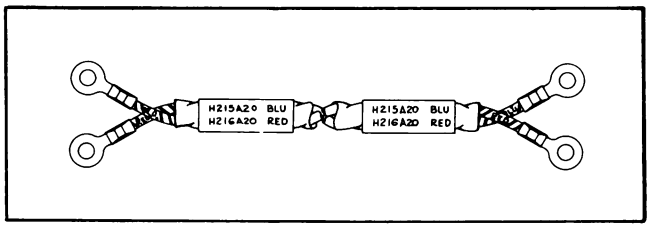


Figure 2–8. Multi Conductor Cable Identification

2–22. MULTICONDUCTOR CABLE IDENTIFICATION. See Figure 2–8. Identify multiconductor cables with marked sleeves installed as described in paragraph 2–21. Stamp sleeves with identification marking of each wire in the cable. Immediately following the identification code, stamp letters indicating the conductor color, using the following abbreviations:

BLK – Black	ORN – Orange
BLU – Blue	PR – Purple
BRN – Brown	RED – Red
GY – Gray	WHT – White
GRN – Green	YEL – Yellow

At each terminating end, strip back outer covering as far as necessary and stamp color code letters on insulation of each conductor.

2–23. COAXIAL CABLE IDENTIFICATION. See Figure 2–9. Identify coaxial cable by direct stamping on the cable or with sleeves. If sleeves are required,

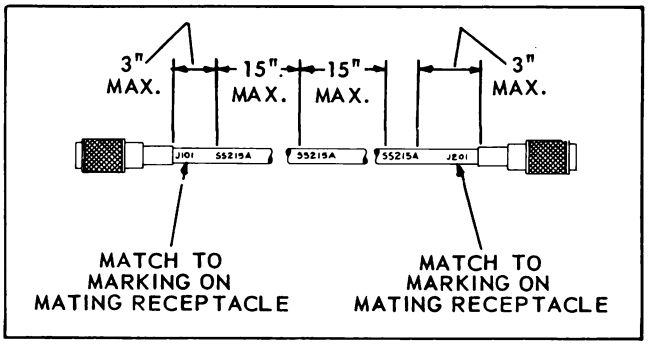


Figure 2–9. Coaxial Cable Identification

install them as indicated in paragraph 2–21. In addition, mark coaxial cable on the end terminating in a piece of equipment to match marking on equipment terminal.

CAUTION

When marking coaxial cable take care not to flatten the cable, as this may change the electrical characteristics of the cable.

2–24. THERMOCOUPLE WIRE IDENTIFICATION. Thermocouple wire which is usually duplexed (two insulated conductors laid side by side) is difficult to mark legibly. Sleeves are installed as described in paragraph 2–21. The wire size of the identification code is replaced by the full name of the material of the thermocouple conductor. Thermocouple conductor materials are Alumel – Chromel – Iron – Constantan – Copper.

2–25. IDENTIFICATION AT TERMINAL BLOCKS AND ENCLOSURES. See Figure 2–10. If possible, mark wires attached to terminal boards and equipment terminals between termination and point where wire is brought into wire bundle. Identify wires terminating in an enclosure inside enclosure if space permits.

2–26. SELECTION OF IDENTIFICATION SLEEVING. For general purpose wiring use flexible vinyl sleeving, either clear or white opaque. For high temperature applications (over 400 degrees F) use silicone rubber or silicone fiberglass sleeving. Where resistance to synthetic hydraulic fluids or other solvents is necessary, use nylon sleeving, either clear or white opaque. Select size of sleeving from Table I.

TABLE I

Sizes of Identification Sleeving

Wire Size MIL–W–5096 AN	Wire Size MIL–W–7072 AL	Sleeving Size No.	Sleeving Size Nominal I.D. (inches)
#24		12	.085
#22		11	.095
#20		10	.106
#18		9	.118
#16		8	.113
#14		7	.148
#12		6	.166
#10		4	.208
#8	#8	2	.263
#6	#6	0	.330
#4	#4	3/8 inch	.375
#2	#2	1/2 inch	.500
#1	#1	1/2 inch	.500
#0	#0	5/8 inch	.625
#00	#00	5/8 inch	.625
#000	#000	3/4 inch	.750
#0000	#0000	3/4 inch	.750

2–27. IDENTIFICATION MARKING MACHINES. See Figures 2–11 and 2–12 for typical marking machines. For stamping a large number of long wires use an automatic wire marking machine. In machines of this type (Figure 2–11) wire sizes #22 through #14 are fed through and stamped automatically. Wires larger than #14 are fed through by hand, but stamped automatically. For short wires, on repair or maintenance work, a hand-operated wire marking machine is more convenient and economical (Figure 2–12). In this type of machine wire is fed through the desired amount by hand, and stamped by operating the handle for each marking. Wire guide holders in sizes to fit wires, and slot holders to hold appropriate size type are furnished to fit the machines. Type is supplied in three sizes, to mark wire #22 through #00 as shown in Table II. Marking foil is available in black or white, (and other colors if needed for special applications)

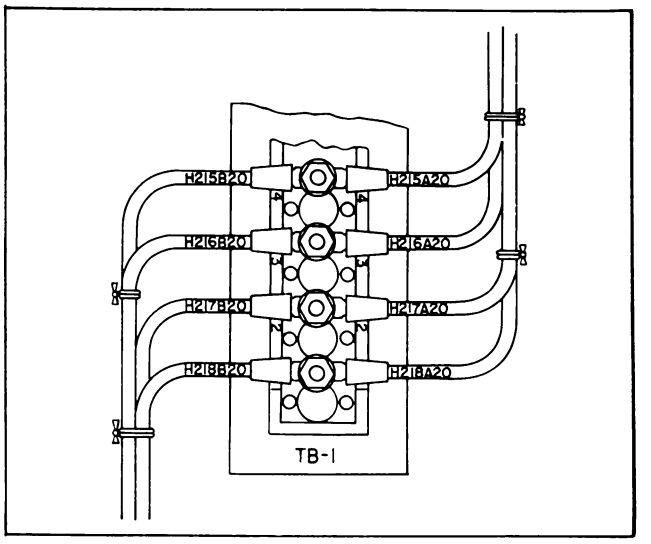


Figure 2–10. Wire Identification at Terminal Block

TABLE II

Recommended Sizes of Marking Type

Wire Size	Height of Letters (inches)
#26 & #22	1/16
#20 thru #14	5/64
#12 thru #0000 Coaxial Cable	7/64

2–28. SET-UP OF MARKING MACHINES FOR WIRE STAMPING. After selecting the proper machine for the job, set it up for the marking procedure as follows: (Refer to Figures 2–11 and 2–12).

a. Select from Table II type of correct size for wire to be marked. Make up required identification code and insert into type holder, centering type in holder. Use spacers to prevent crowding letters and numbers.

b. Select marking foil of correct width for length of marking. Use black foil for light colored insulation, and white foil for dark insulation.

c. Select wire guide holder with wire hole to fit wire, and having a slot of same length as slot in type holder.

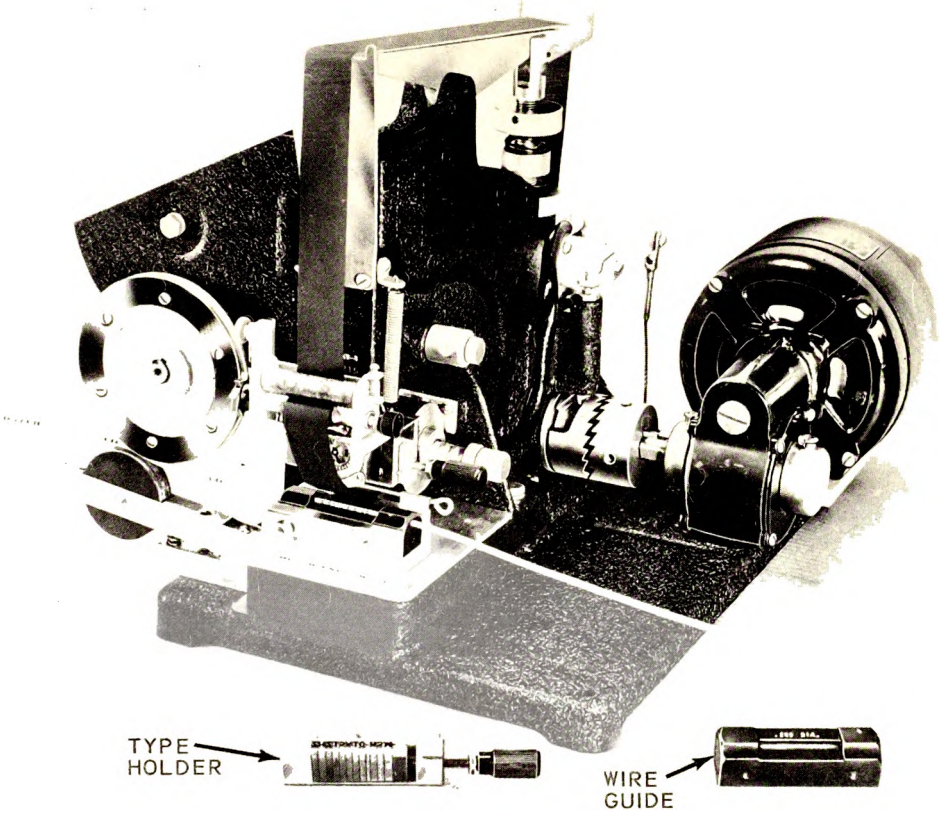


Figure 2–11. Marking Machine – Automatic

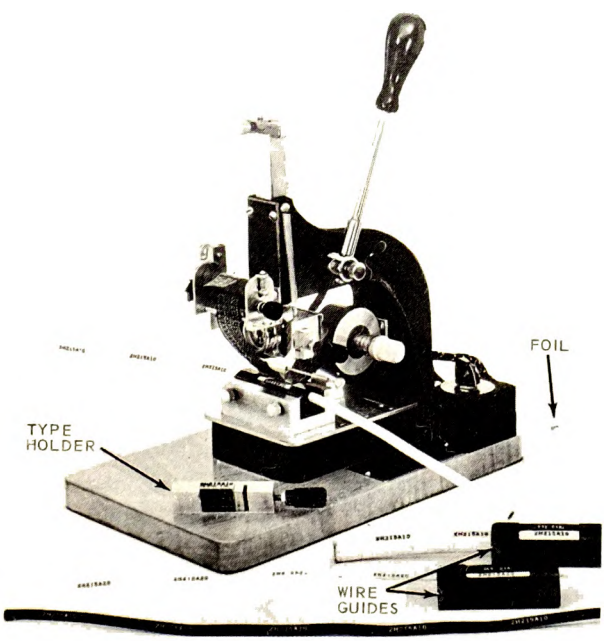


Figure 2–12. Marking Machine – Hand

CAUTION

Use smallest guide into which wire will fit. If guide is too large, wire will not be held firmly, and will be off-center.

d. Install wire guide and roll of marking foil on machine. Slide type holder into slot provided for it.

2–29. PROCEDURE FOR WIRE STAMPING BY MACHINE. The procedure for stamping wire by machine is as follows:

NOTE

Good marking is obtained only by the proper combination of temperature and pressure, and is arrived at by trial.

CAUTION

Avoid excessive heat or pressure, as it may damage the wire insulation.

a. Turn heat to high, then regulate downward to required temperature. See Table III for recommended temperatures.

NOTE

Store foils at approximately 70°F and 60% relative humidity.

TABLE III

Recommended Marking Temperatures

Insulation Material	*Recommended Temperature*
Cotton	275 – 325°F
Vinyl	325 – 375°F
Nylon	425 – 450°F
*Teflon	425 – 450°F
Rockbestos	425 – 450°F

*Teflon insulated wire requires heavier pressure for longer time. Foil for marking Teflon insulated wire should be kept slightly moist.

b. Insert piece of sample or scrap wire into wire guide, and adjust pressure control until mark is sharp and clear. Impression should be just deep enough to sink slightly below surface of insulation, but should not cut into it. The pressure adjustment also controls the length of dwell in automatic machines.

c. When a satisfactory marking has been made, remove sample, wire, and insert wire to be marked into wire guide, far enough so that first marking will be made about three inches from end.

d. Operate foot pedal (or hand lever) to make mark.

e. It is desirable (but not mandatory) to rotate wire 180 degrees and mark again on other side.

f. Mark remaining wire length. If marks are to be spaced at intervals of eight inches or less, operate machine automatically. If intervals are greater than eight inches, or if wire is larger than size #8 (regardless of spacing) pull wire through by hand, and operate machine at desired spacing. If practicable, rotate wire back and forth at each mark through 180 degrees to mark on opposite side. During marking procedure, check permanence of mark from time to time by rubbing with a clean dry cloth. If mark smears, or becomes hard to read, adjust machine to correct condition, and re-mark wire.

2–30. SET-UP OF MARKING MACHINE FOR SLEEVE STAMPING. For stamping identification mark on tubing that has an O.D. of 1/4 inch or smaller, use the same machine that is used for stamping wire. Set up machine as follows:

a. Select type size and wire guide to suit O.D. of tubing.

b. Select mandrel (metal rod) of a diameter that will fit snugly inside tubing. Insert mandrel into tubing, and both into wire guide. If mandrel of proper size is not available, use piece of insulated wire of suitable diameter and length.

c. Prepare type as described in paragraph 2–28, step a.

d. Select foil, and install wire guide, foil and type holder on machine as described in paragraph 2–29, steps b, and d.

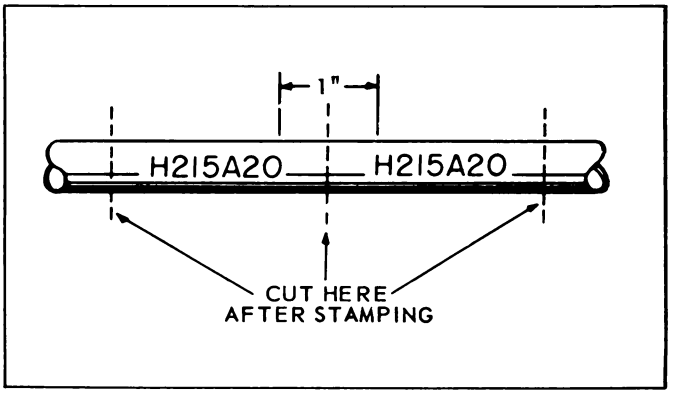


Figure 2–13. Marking on Sleeves

2–31. PROCEDURE FOR STAMPING SLEEVES BY MACHINE. To mark tubing, follow procedure for marking wire as described in paragraph 2–29, steps a through e. After first mark, mark remaining tubing at intervals that will leave about one inch between marks (See Figure 2–13). Rotate at each marking to mark again on opposite side.

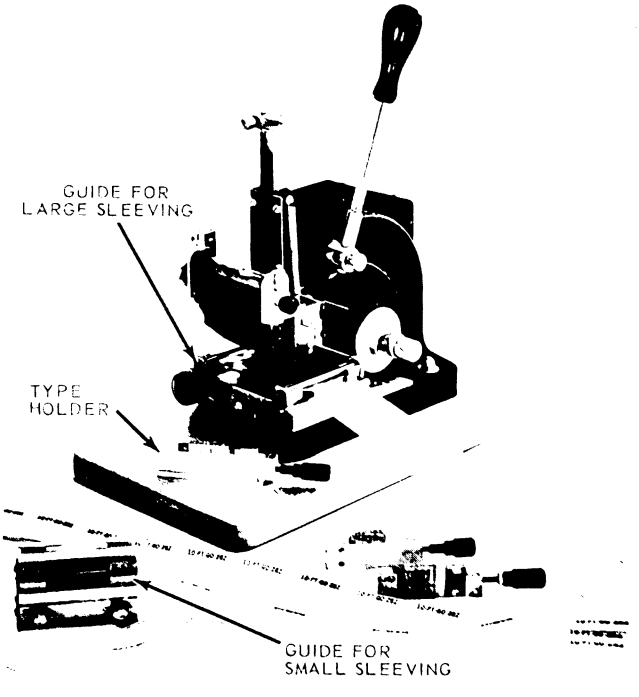


Figure 2–14. Marking Machine for Sleeving

2–32. MACHINE STAMPING FOR LARGE SLEEVING. See Figure 2–14. To mark tubing that has O.D. larger than 1/4 inch, use a special machine that marks tubing flat, if it is available. Flat type rather than curved type is used on this machine. Otherwise, machine set-up and marking procedure is same as that described in paragraphs 2–30 and 2–31.

2–33. INSTALLING IDENTIFICATION SLEEVES ON WIRING. Cut marked tubing into lengths so that mark-

ing is approximately centered (refer to Figure 2–13). Install cut lengths of tubing over wire or cable at desired spacing, and tie at each end with clove hitch and square knot. See Section XII for method of tying and knotting.

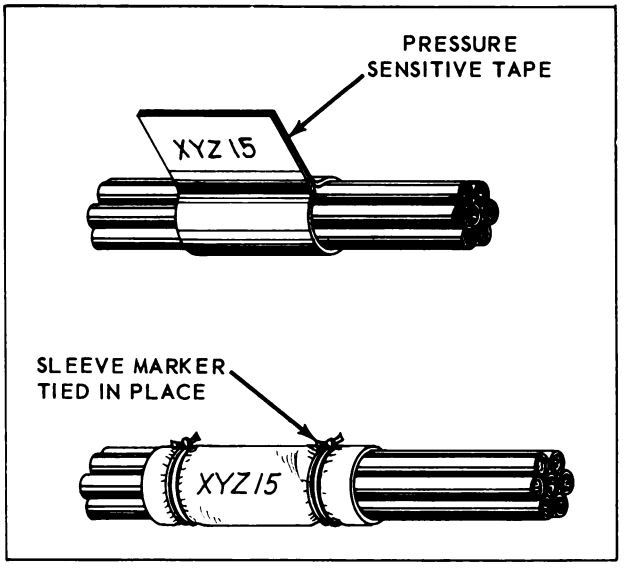


Figure 2–15. Identification of Wire Bundles & Harnesses

2–34. IDENTIFICATION OF WIRE BUNDLES AND HARNESSES. See Figure 2–15. Identification of bundles and harnesses is not mandatory. If identification is desired, use one of the following methods:

a. If bundle is not too large select sleeving of proper size to fit snugly over wire bundle. Stamp with identification marking as described in paragraph 2–32 and install on bundle approximately 12 in. from each terminating end. Tie securely at both ends.

NOTE

If wires are not free at one end, sleeving must be installed on bundle before soldering wires to connectors.

b. Stamp identification number on pressure tape, lay tape around bundle approximately 12 in. from each terminating end and press two ends of tape together to form a flag on which marking is printed.

2–35. STRIPPING WIRE AND CABLE.

2–36. GENERAL. Before wire can be assembled to connectors, terminals, splices, etc., the insulation must be stripped from connecting ends to expose the bare conductor. For attachment to connectors enough insulation is stripped so that conductor will bottom in solder cup and leave a small gap between the top of the solder cup and cut end of insulation. Stripping dimensions for AN connectors will be found in Section III, for RF connectors in Section IV, and for terminals in Section V. See Figure 2–16 for typical tools used in wire stripping.

2–37. STRIPPING METHODS FOR COPPER WIRE. Copper wire may be stripped in a number of ways depending on size and insulation. See Table IV for a summary of wire strippers.

TABLE IV

Wire Strippers for use on Copper Wire

Stripper	*AN Gauge No.*	*Insulations*
Hot-Blade	#26 – #4	All except asbestos
Rotary, electric	#26 – #4	All
Bench	#20 – #6	All
Hand pliers	#26 – #8	All
Knife	#2 – #0000	All

Details of each method are given in paragraphs 2–40 thru 2–44.

2–38. STRIPPING METHODS FOR ALUMINUM WIRE. Strip aluminum wires with a knife as described in paragraph 2–44. AL#6 and AL#8 can also be stripped by means of a hot-blade stripper as described in paragraph 2–40. Strip aluminum wire very carefully. Take extreme care not to nick aluminum wire, as strands break very easily when nicked.

2–39. GENERAL STRIPPING INSTRUCTIONS. When stripping wire with any of the tools mentioned in paragraphs 2–37 and 2–38 observe the following precautions.

a. When using hot-blade stripper, make sure that blades are clean. Clean blades with a brass wire brush as necessary.

b. Make sure all stripping blades are sharp, and free from nicks, dents, etc.

c. When using any type of wire stripper, hold wire perpendicular to cutting blades.

d. Adjust automatic stripping tools carefully; follow manufacturer's instructions, to avoid nicking, cutting, or otherwise damaging any strands. This is especially important for all aluminum wires and for copper wires smaller than #10. Examine stripped wires for damage, and adjust tool as necessary. Cut off and re-strip (if length is sufficient); or reject and replace any wires with more than the allowable number of nicked or broken strands given in Table V.

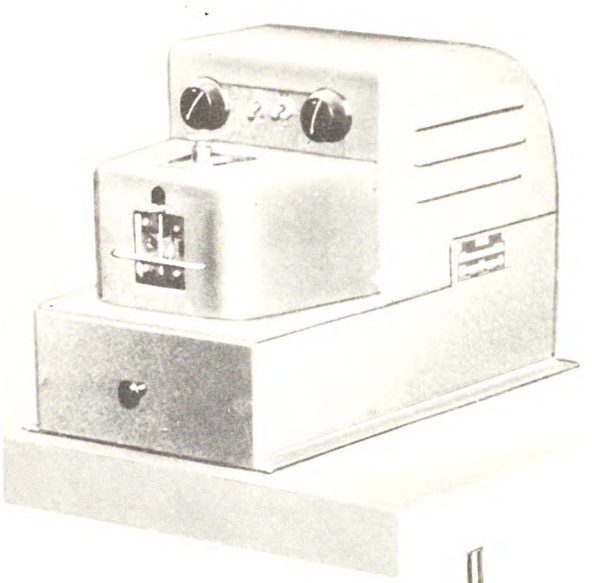
TABLE V

Allowable Nicked or Broken Strands

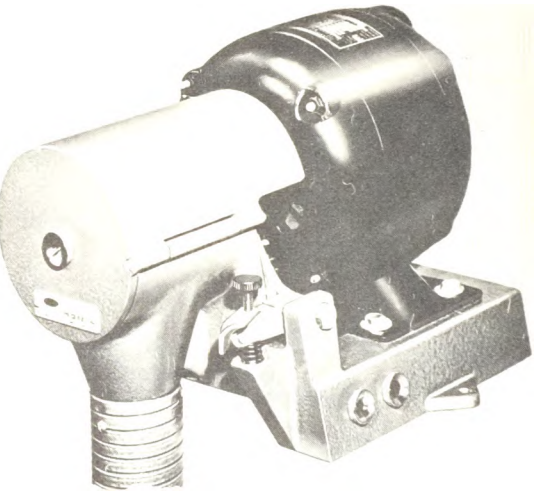
Wire Size	*Nicked or Broken Strands*
Copper	
AN #22 – #12	None
#10	2
#8 – #4	14
#2 – #0	12
Aluminum	
All Sizes	None

NOTE

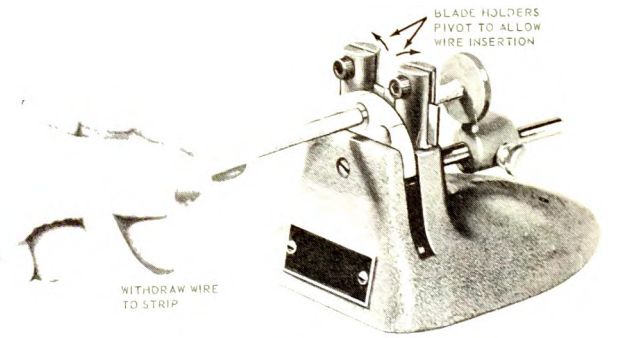
Longitudinal scratches in copper wire are not considered cause for rejection or rework.



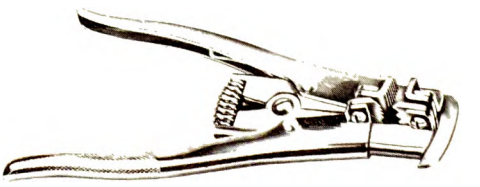
(a) HOT BLADE WIRE STRIPPER



(b) ROTARY WIRE STRIPPER



(c) BENCH WIRE STRIPPER



(d) HAND WIRE STRIPPER – HEAVY DUTY

(e) HAND WIRE STRIPPER – LIGHT DUTY

Figure 2–16. Typical Wire Stripping Tools

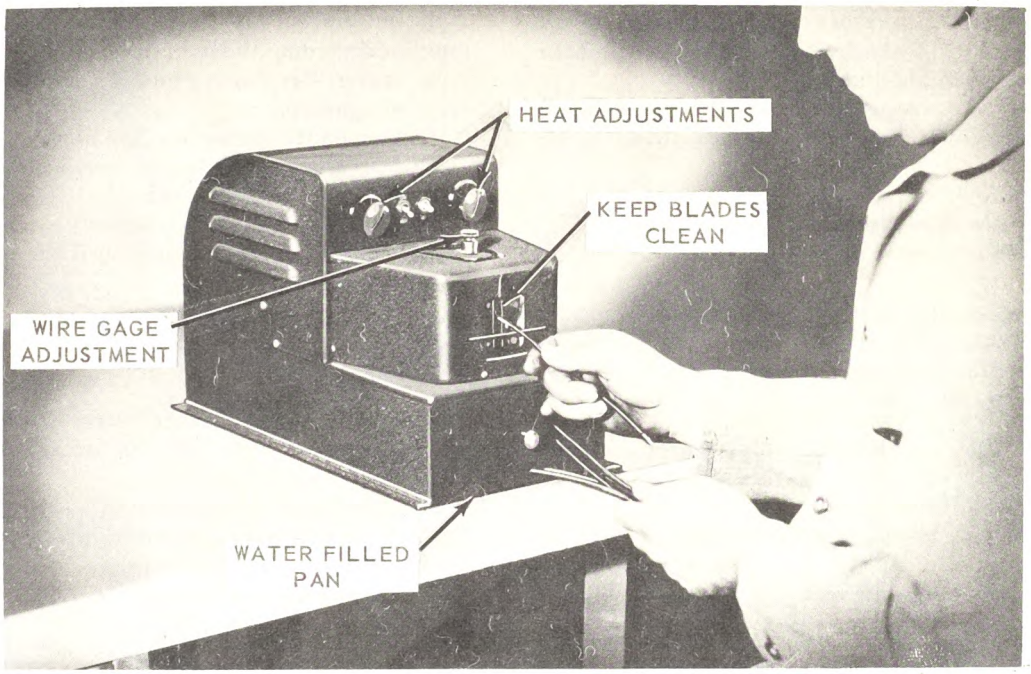


Figure 2–17. Stripping Wire in a Hot Blade Stripper

f. Make sure insulation is clean-cut with no frayed or ragged edges. Trim if necessary.

g. Make sure all insulation is removed from stripped area. Some types of wires are supplied with a clear transparent layer between conductor and primary insulation. If this is present, remove it.

h. When using handplier strippers to remove lengths of insulation longer than 3/4 inch, it is easier to do in two or more operations.

j. Retwist copper strands by hand or with pliers if necessary to restore natural lay and tightness of strands.

2–40. PROCEDURE FOR STRIPPING WIRE WITH HOT-BLADE STRIPPER. The procedure for stripping wire with hot-blade stripper is as follows:

a. Adjust blades to correct opening for size of wire to be stripped. See Figure 2–17.

b. Adjust stop by means of knurled brass nut on top of hood, for desired stripping length between 1/4 in. and 1-1/2 in.

c. Adjust each blade to proper heat by trying on sample pieces of wire. Use minimum heat that will remove insulation satisfactorily without damaging strands.

d. Insert wire until it butts against stop.

e. Press foot pedal to bring heated blades against insulation.

f. Twist wire about 90 degrees and pull out.

2–41. SUBSTITUTE HOT-BLADE STRIPPER. Where a hot-blade wire stripper is not available, a substitute can be made and used as follows: See Figure 2–18.

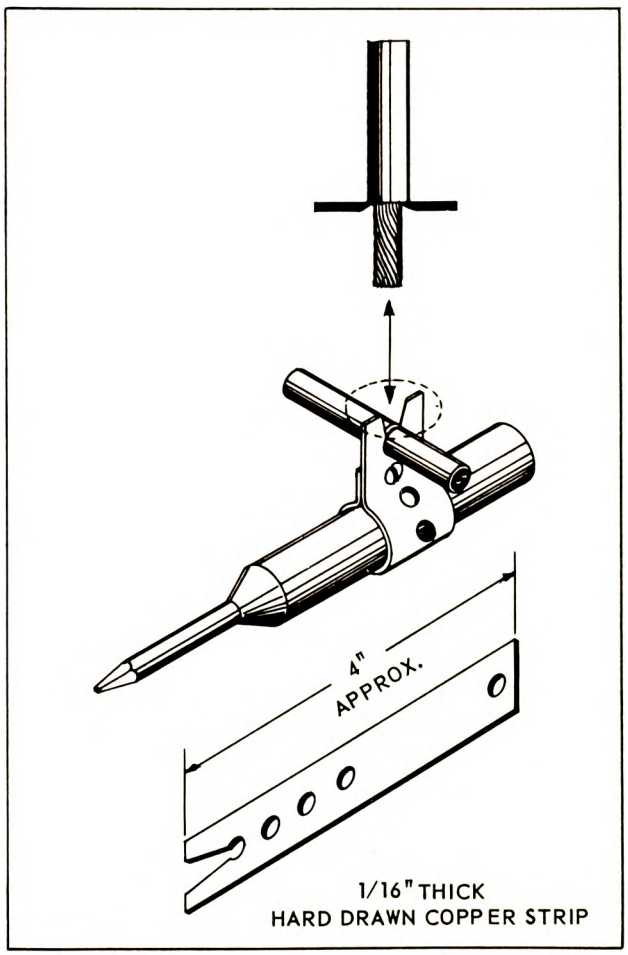


Figure 2–18. Substitute Hot Blade Stripper

a. In the end of a piece of copper strip, cut a sharp edged "V". At the bottom of the "V" make a wire slot of suitable diameter.

b. Fasten the copper strip around the heating element of an electric soldering iron as shown in the figure.

c. Lay wire or cable to be stripped in the "V"; a clean channel will be melted in the insulation.

d. Remove insulation with slight pull.

2-42. PROCEDURE FOR STRIPPING WIRE WITH POWER ROTARY STRIPPER. Refer to Figure 2-19. The procedure for stripping wire or cable with a rotary-type stripper is as follows:

a. Select and install bushing of proper size for wire to be stripped. Bushings are available in 1/8 in., 1/4 in. and 3/8 in. sizes.

b. Set butt for length of strip desired from 1/4 in. to 1-3/4 in.

c. Make adjustment for wire gage.

d. Set switch for clockwise or counterclockwise rotation according to lay of strands.

e. Insert wire through bushing until end of wire is stopped against butt.

f. Step on foot pedal to close blades on wire.

g. Pull sharply on wires to remove insulation.

h. Examine wire to be sure all insulation is removed and also that strands are not nicked or cut. Reset wire gage adjustment (step c) if necessary.

2-43. PROCEDURE FOR STRIPPING WIRE WITH HAND STRIPPER. Refer to Figure 2-20. The procedure for stripping wire with plier-type hand strippers is as follows:

a. Insert wire into exact center of correct cutting slot for wire size to be stripped. (Each slot is marked with wire size).

b. Close handles together as far as they will go.

c. Release handles, allowing wire holder to return to open position.

d. Remove stripped wire.

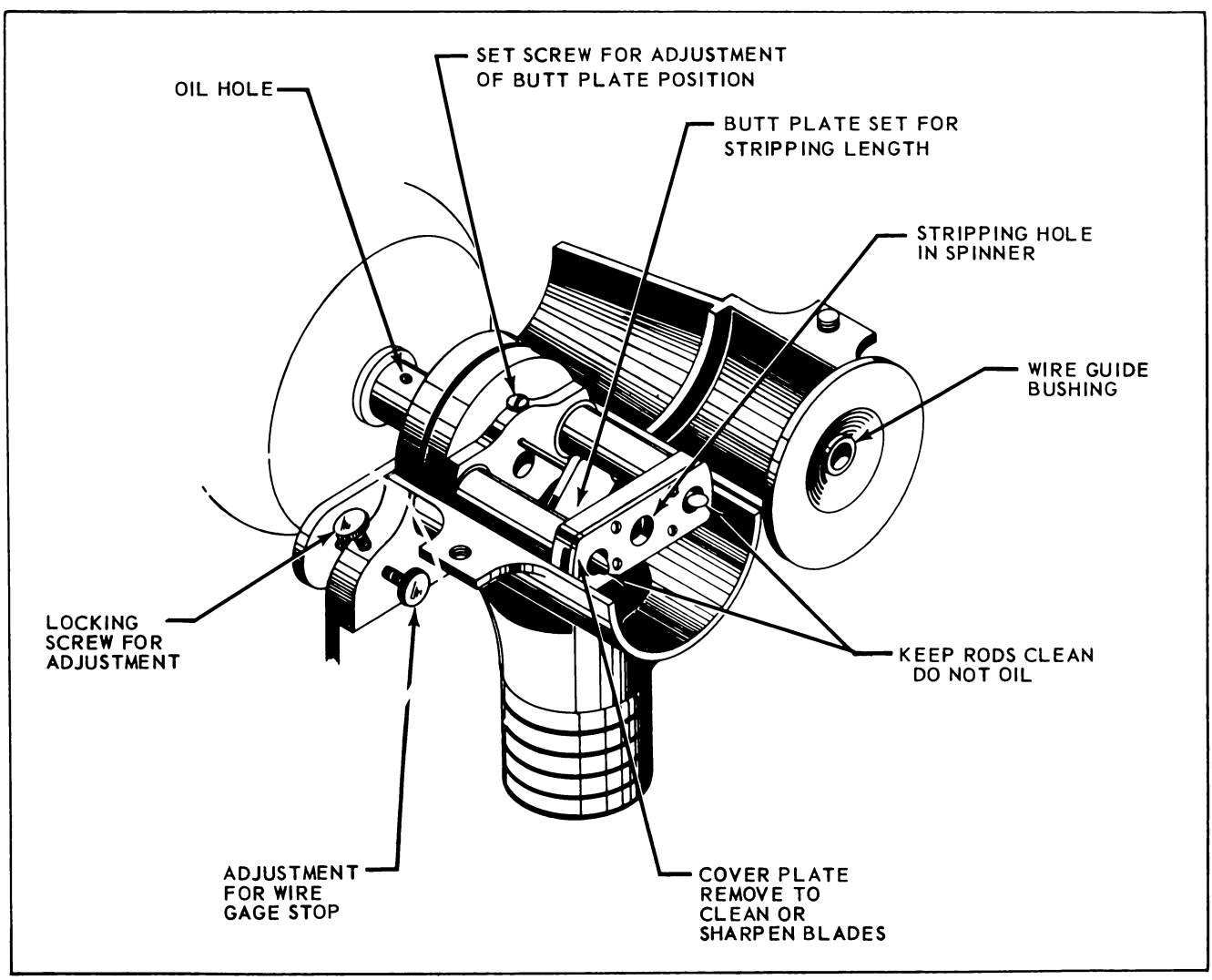


Figure 2-19. Inside View of Rotary Wire Stripper

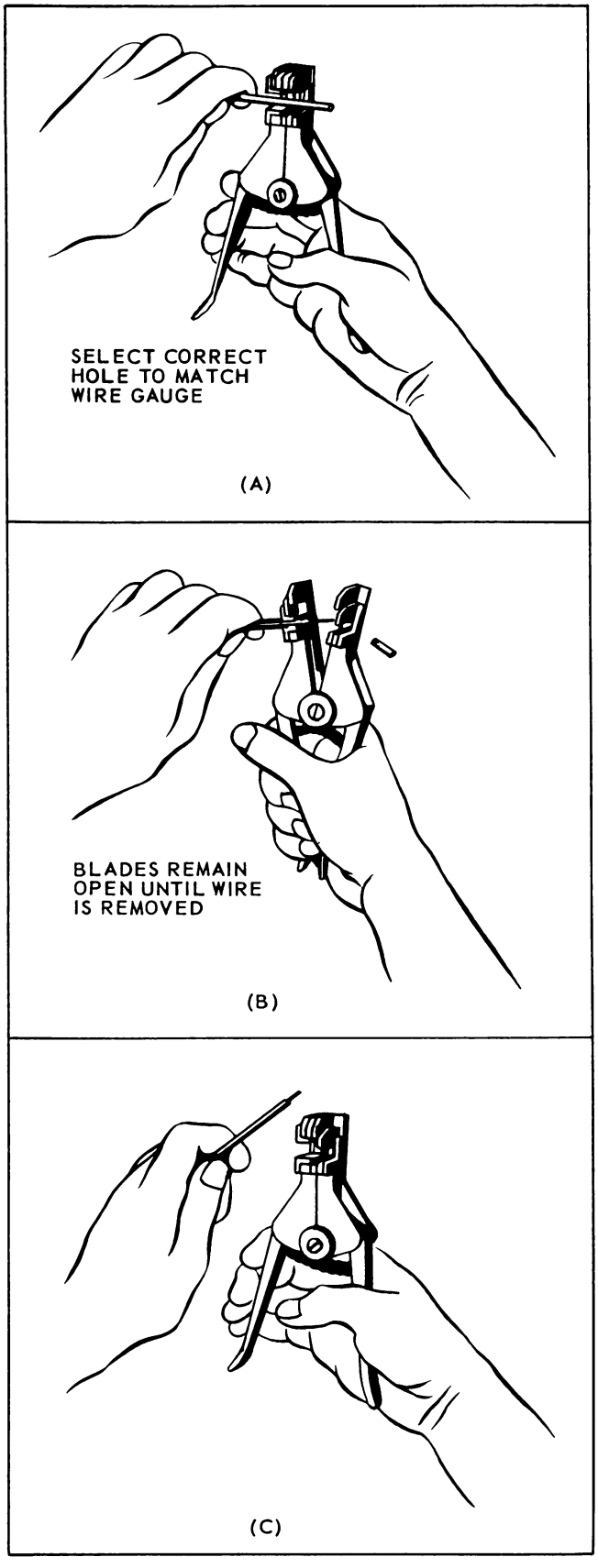


Figure 2–20. Stripping Wire With Hand Stripper

NOTE

Jaws will not snap back until wire is removed.

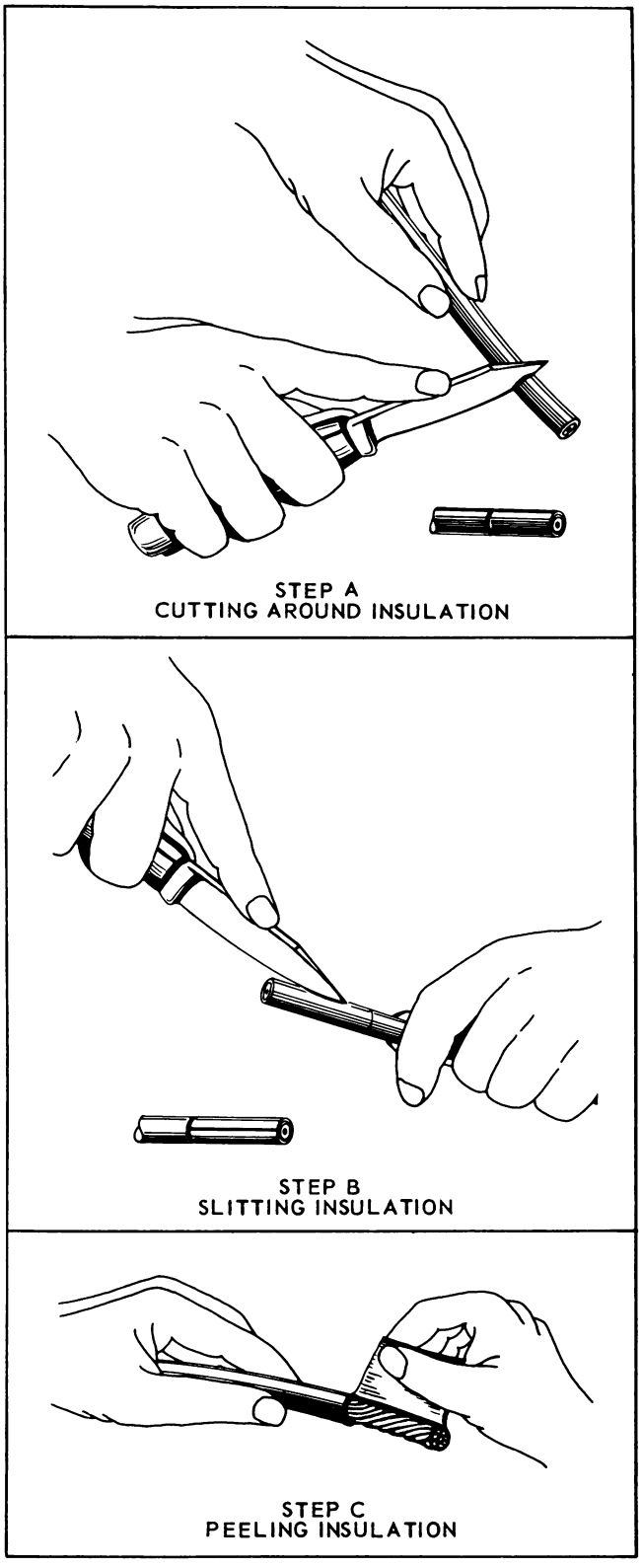


Figure 2–21. Knife Stripping

2–44. PROCEDURE FOR STRIPPING WIRE WITH A KNIFE. See Figure 2–21. The procedure for stripping wires with a knife is as follows:

CAUTION

Take care not to nick or cut strands.

a. Make cut around wire at desired strip length. Do not cut completely through the insulation.

b. Make second cut lengthwise along stripping length. Do not cut completely through insulation.

NOTE

When a wire has two or more layers of insulation, cut through outer layers and only score innermost.

c. Peel off insulation, following lay of strands.

2–45. STRIPPING DIMENSIONS FOR ASSEMBLY TO CONNECTORS. Stripped lengths on wires which are to be attached to connectors should be such that when stripped conductor bottoms in solder cup there will be a gap of approximately 1/32 in. between the end of the cup and the end of the insulation, for inspection purposes.

2–46. TINNING COPPER WIRE AND CABLE.

2–47. GENERAL. Before copper wires are soldered to connectors the ends exposed by stripping are tinned to hold the strands solidly together. The tinning operation is considered satisfactory when the ends of the strands and sides of the strands are fused together with a coat of solder. Do not tin wires which are to be crimped to Class K (fire-proof) connectors, or wires which are to be attached to solderless terminals or splices.

2–48. TINNING METHODS. Copper wires are usually tinned by dipping into flux and then into a solder bath. In the field, copper wires can be tinned with a soldering iron and rosin core solder.

2–49. EXTENT OF TINNING. Tin conductor for about half its exposed length. This is enough to take advantage of closed part of solder cup. Tinning or solder on wire above cup causes wire to be stiff at point where flexing takes place. This will result in wire breakage.

2–50. PREPARATION OF FLUX AND SOLDER. The flux used to tin copper wire is a mixture of denatured alcohol and freshly ground water-white rosin in the proportion of eight ounces of alcohol to one ounce of rosin, mixed together thoroughly and well shaken. During use the alcohol will evaporate and should be replaced. The solder used is a mixture of 60% tin and 40% lead. Maintain temperature of the solder pot between 450 and 500 degrees F; this will keep solder in a liquid state. Skim surface of solder pot as necessary with a metal spoon or blade to keep solder clean and free from oxides, dirt, etc.

CAUTION

Do not use any other flux or solder for tinning copper wires for use in aircraft electrical systems.

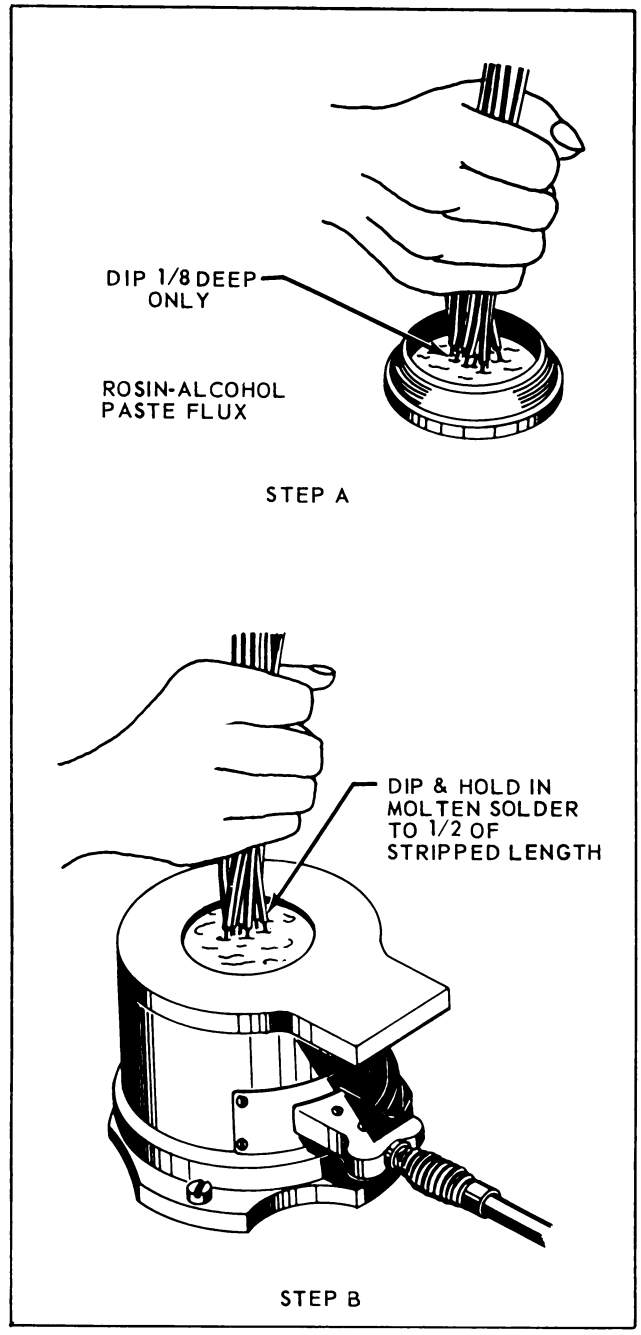


Figure 2–22. Dip Tinning in Solder Pot

2–51. DIP-TINNING PROCEDURE. Dip-tin wires smaller than #8 about eight or ten at a time. Dip-tin wires size #8 and larger individually.

CAUTION

During tinning operation, take care not to melt, scorch or burn the insulation.

The procedure for dip-tinning is as follows:

a. Prepare flux and solder as described in paragraph 2–50.

b. Make sure that exposed end of wire is clean and free from oil, grease and dirt. Strands should be straight and parallel. Dirty wire should be restripped.

c. Grasp wire(s) firmly and dip into dish of prepared flux to a depth of about 1/8 inch.

d. Remove wire and shake off excess flux.

e. Immediately dip into molten solder. Dip only half of stripped conductor length into solder.

f. Manipulate wires slowly in solder bath until they are thoroughly tinned. Watch the solder fuse to wire. Do not keep wire(s) in bath longer than necessary.

g. Remove wires and shake off excess solder.

NOTE

The thickness of the solder coat depends on the speed with which the wires are handled and shaken, and the temperature of the solder bath.

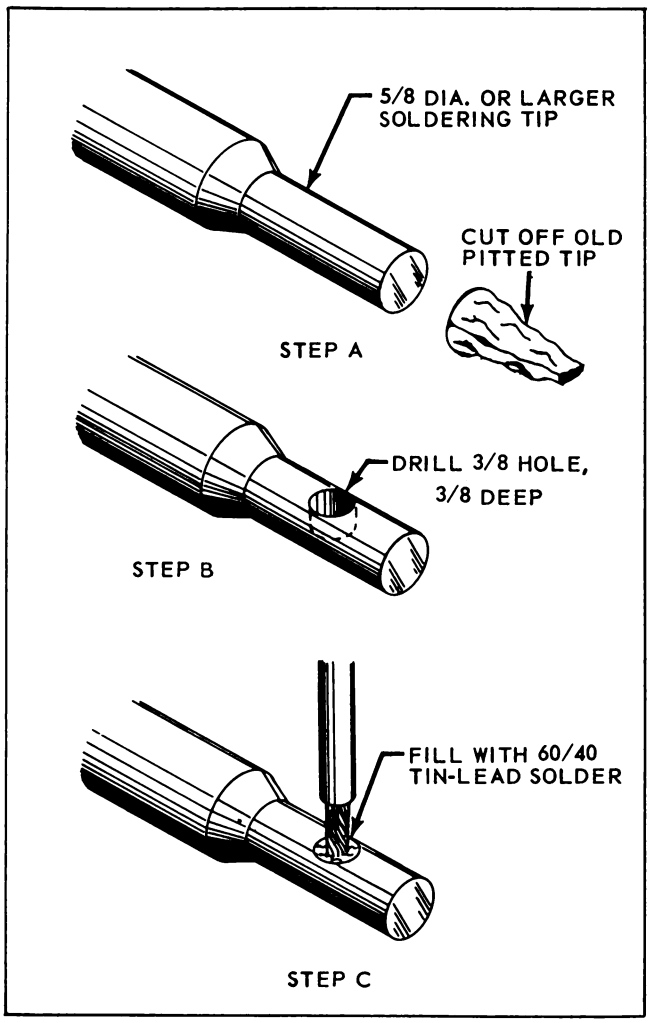


Figure 2–23. Alternate Dip-Tinning Method

2–52. ALTERNATE DIP-TINNING PROCEDURE. See Figure 2–23. If an electrically heated solder pot is not available, a small quantity of wires may be tinned by means of the following procedure:

a. Cut off beveled section of tip of a discarded soldering iron tip.

b. Drill hole (1/4 to 3/8 inch diameter) in cylindrical part of tip, about two thirds through.

c. Heat up iron, and melt rosin-core solder into hole.

d. Tin wires by dipping into molten solder one at a time.

e. Keep adding fresh rosin-core solder as the flux burns away.

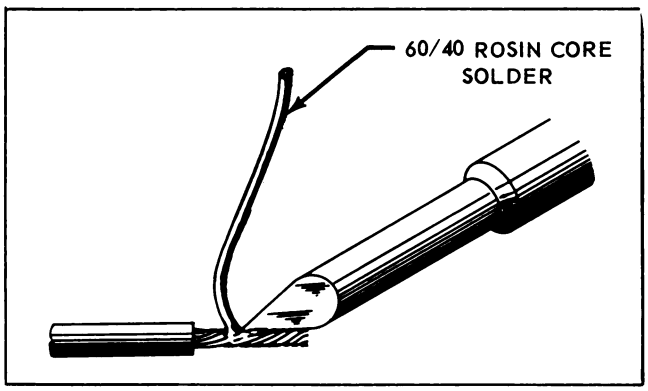


Figure 2–24. Soldering Iron Tinning

2–53. PROCEDURE FOR SOLDERING IRON TINNING. See Figure 2–24. In the field wires smaller than size #10 may be tinned with a soldering iron and rosin core solder as follows:

a. Select a soldering iron having suitable heat capacity for wire size from Table VI. Make sure that iron is clean and well-tinned.

TABLE VI

Approximate Soldering Iron Sizes for Tinning

Wire Size (AN Gage)	*Soldering Iron Size (Heat Capacity)*
#20 – #16	65 Watts
#14 & #12	100 Watts
#10 & #8	200 Watts

b. Prime by holding iron tip and solder together on wire until solder begins to flow.

c. Move soldering iron to opposite side of wire and tin half of the exposed length of conductor.

2–54. TERMINATING SHIELDED CABLE.

2–55. GENERAL. Shielded cable has a metallic braid over the insulation to provide a barrier around the conductor through which electro-static energy (noise or interference) cannot pass. To obtain satisfactory results from shielded cable, the shield must

be unbroken and must extend to a point as near the end of the conductor as practicable. Shielded cable is either grounded or dead-ended at each end as required by the individual installation. The following paragraphs describe these procedures.

2–56. STRIPPING JACKET ON SHIELDED CABLE. Some shielded cable has a thin extruded plastic coating over the shielding braid. Strip this off as far as necessary with a hot blade stripper, as described in paragraphs 2–40 or 2–41. Length of strip depends on method of shield termination and type of wire connection. Strip outer jacket back far enough for ease in working. If no hot-blade stripper is available, use plier type hand strippers for sizes #22 through #10, and a knife for sizes larger than #10. Be careful not to damage shielding braid.

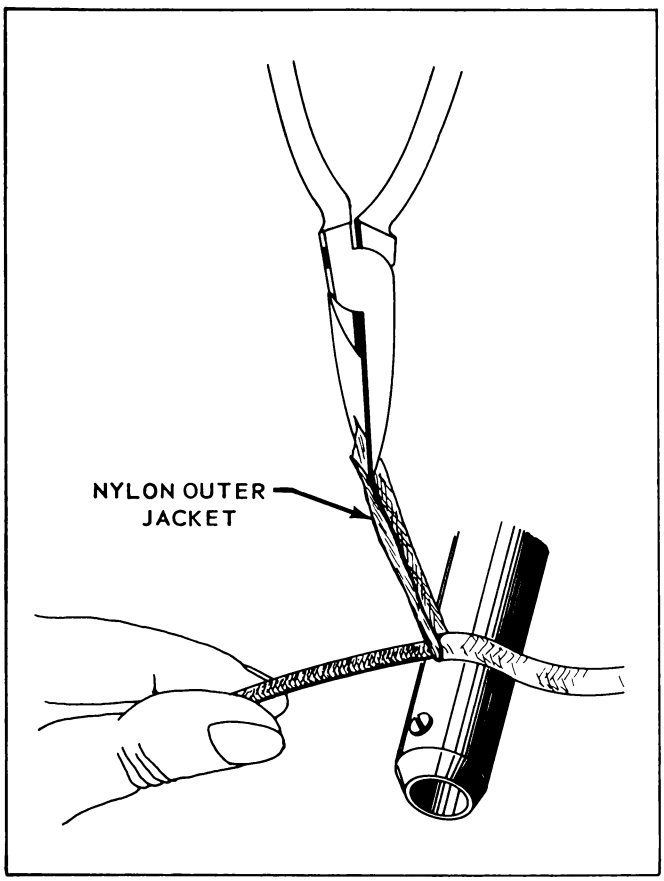


Figure 2–25. Stripping Outer Jacket from Shielded Cable

Extruded jacket of shielded twisted wires can also be stripped by holding a soldering iron, with tip removed, against jacket, and pulling off jacket with long nose pliers as iron melts jacket.

2–57. GROUNDING SHEATH CONNECTOR METHOD OF SHIELD TERMINATION. See Figure 2–26. When the metallic braid of shielded cable can be easily flared out, the preferred method of terminating the shield is by crimping it, with or without a ground wire

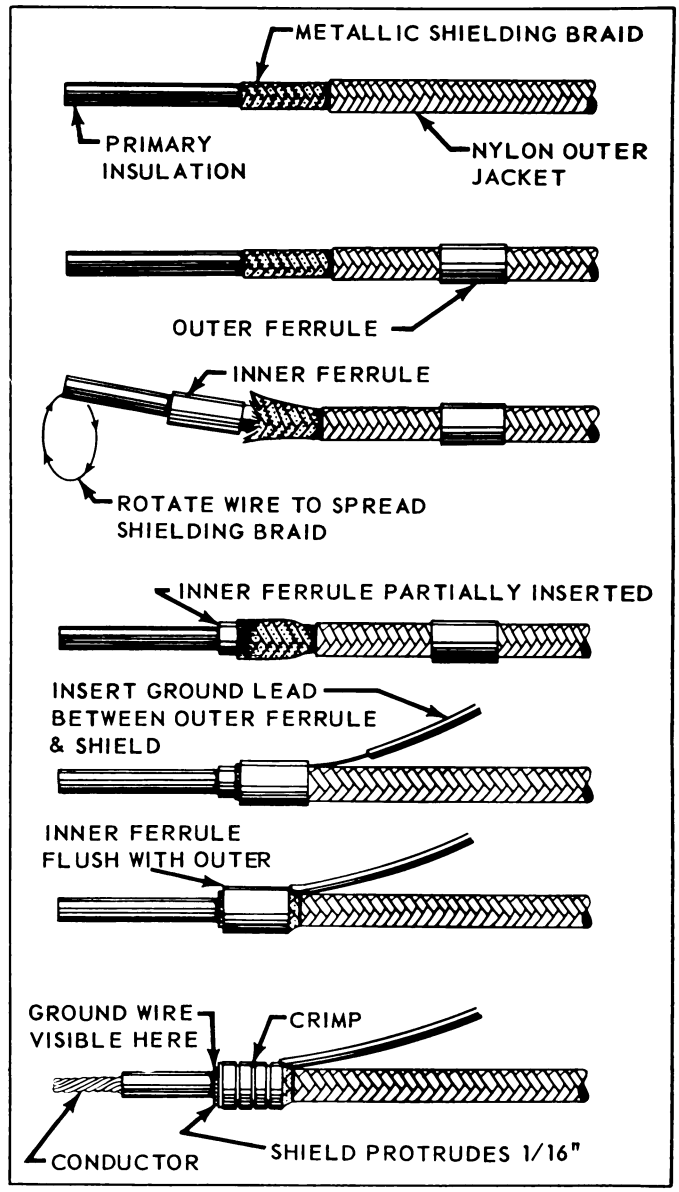


Figure 2–26. Grounding Sheath Connection for Terminating Shielded Wire

as required, between two sleeves (or ferrules). The procedure is as follows:

a. Strip off shielding braid (and outer jacket if present) with hand strippers or scissors. Length to be stripped is determined by length of unshielded conductor necessary for making connection.

b. Strip outer jacket (if present) 1/2 to 3/4 inch.

c. Measure O.D. of insulation directly under shield. See Figure 2–2a.

d. Add .005 inch minimum to O.D. obtained in step C, and select inner sleeve having the nearest larger I.D. from Table VII.

e. Note O.D. of inner sleeve selected in step d, and add .025 inch minimum to it to allow for thickness of shielding braid. Add an extra .030 to .040 to allow clearance for a #20 or #18 ground *wire* if required.

TABLE VII

Shielded Wire Terminations – Inner Sleeves

OD Under Shield	Inner Sleeve I.D.	Inner Sleeve O.D.	Thomas & Betts GSB#	Burndy YPV#
.070 – .075	.080	.103	–	6G3
.075 – .085	.090	.113	–	6G4
.085 – .091	.096	.119	096	–
.091 – .096	.101	.124	101	6G5
.096 – .104	.109	.131	109	6G8
.104 – .110	.115	.146	–	76P2
.110 – .119	.124	.145	124	8G2
.110 – .120	.125	.156	–	81P2
.119 – .123	.128	.152	128	–
.123 – .129	.134	.156	134	–
.129 – .144	.149	.179	149	–
.129 – .145	.150	.181	–	95P2
.145 – .151	.156	.191	156	102P2
.151 – .160	.165	.194	165	–
.160 – .170	.175	.215	175	–
.170 – .175	.180	.204	–	111P2
.175 – .182	.187	.217	187	–
.182 – .189	.194	.225	194	124P2
.189 – .200	.205	.245	205	–
.200 – .214	.219	.250	219	–
.214 – .220	.225	.254	225	–
.220 – .227	.232	.263	232	–
.227 – .255	.261	.297	261	161P2
.255 – .270	.275	.306	275	–
.270 – .276	.281	.331	281	–
.276 – .282	.287	.327	287	–
.282 – .292	.297	.336	297	188P2
.292 – .307	.312	.362	312	–

From Tables VIII or IX select an outer sleeve, with the above dimension as minimum I.D.

NOTE

Inner and outer sleeves should be selected from the same manufacturer at all times.

TABLE VIII

Shielded Wire Terminations – Outer Sleeves and Installing Tools – Thomas & Betts

Outer Sleeves		Installing Tools	
Catalogue Number	I.D. Inches	Hand	Power
GSC 149	.149	WT 201	21501
156	.156	202	21502
175	.156	203	21503
187	.187	206	21506
194	.194	206	21506
199	.199	206	21506
205	.205	208	21508
219	.219	208	21508
225	.225	309	21509
232	.232	210	21510
261	.261	211	21511
275	.275	212	21512
281	.281	214	21514
287	.287	214	21514
297	.297	214	21515
312	.312	215	21516
327	.327	216	21517
348	.348	217	21518
405	.405	218	21519

TABLE IX

Shielded Wire Terminations – Outer Sleeves and Installing Tools – Burndy

Outer Sleeve		Installing Tools	
Catalogue Number	I.D. Inches	Latchet Hand Tool	Die Set For Power Tools Y10R, Y10Q & Y10NCP
YPV 80	.125	MR8PV	R8VT
100	.156	MR8PV, MR8PV-1	R10VT
110	.180	"	"
120	.187	"	R12VT
128	.199	"	"
130	.207	"	"
140	.219	MR8PV	R14VT
150	.235	MR8PV-1	R16VT
160	.261	MR8PV-2	R16VT
180	.281	"	R18VT
190	.300	"	R18VT
200	.312	– – –	R20VT
220	.344	MR8PV-4	R22VT
240	.375	– – –	R24VT
250	.405	– – –	R25VT

f. Slide outer sleeve back over insulation and braid.

g. Rotate cable with circular motion to flare out braid.

h. Slip inner sleeve under braid so that about 1/16 inch of sleeve sticks out beyond braid.

i. Insert stripped ground wire under outer sleeve (if required) and slide both forward over braid and inner sleeve until only 1/32 to 1/16 inch of inner sleeve and braid protrude. See Figure 2-26. Ground wire may extend from front or back of outer sleeve as required.

CAUTION

Examine assembly to make sure that shield braid and ground wire come through under the outer sleeve.

j. Crimp with hand tool or power tool with correct die selected from Tables VIII or IX.

2-58. PIGTAIL METHOD OF SHIELD TERMINATION. When grounding sheath connectors and tools are not available, terminate shield for grounding by making a pigtail as follows: See Figure 2-27.

CAUTION

Take extreme care not to damage shielding or insulated conductor while forming pigtail.

a. Determine and mark point where shielding is to terminate. This depends on the individual installation.

b. Push back shielding to form a bubble at the termination point.

c. Insert an awl, or other pointed tool into shielding braid at termination point and work an open circular area in the shield. Be careful not to cut into wire insulation.

d. Bend cable, insert tool between shielding and wire, and pull insulated conductor through hole formed by tool.

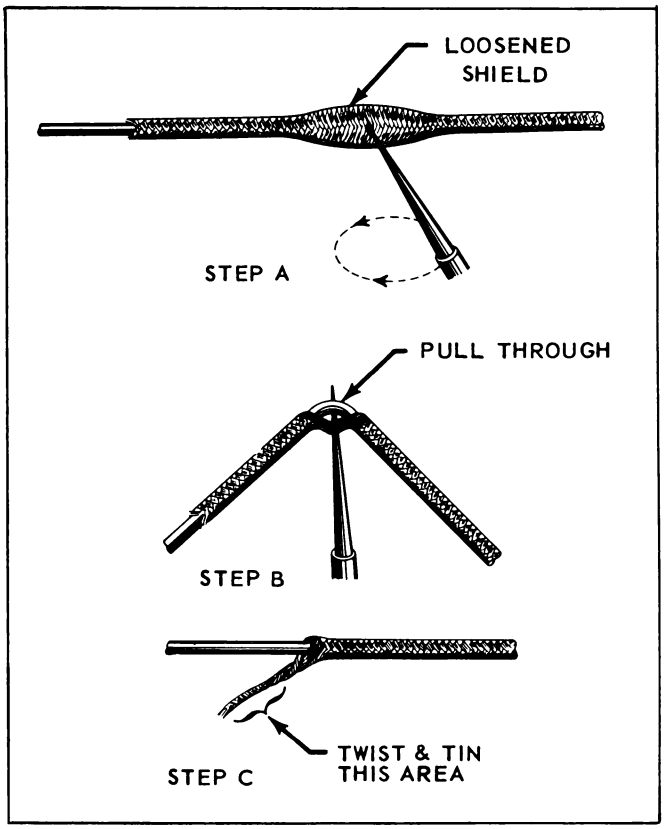


Figure 2–27. Pigtail Termination for Shielded Wire

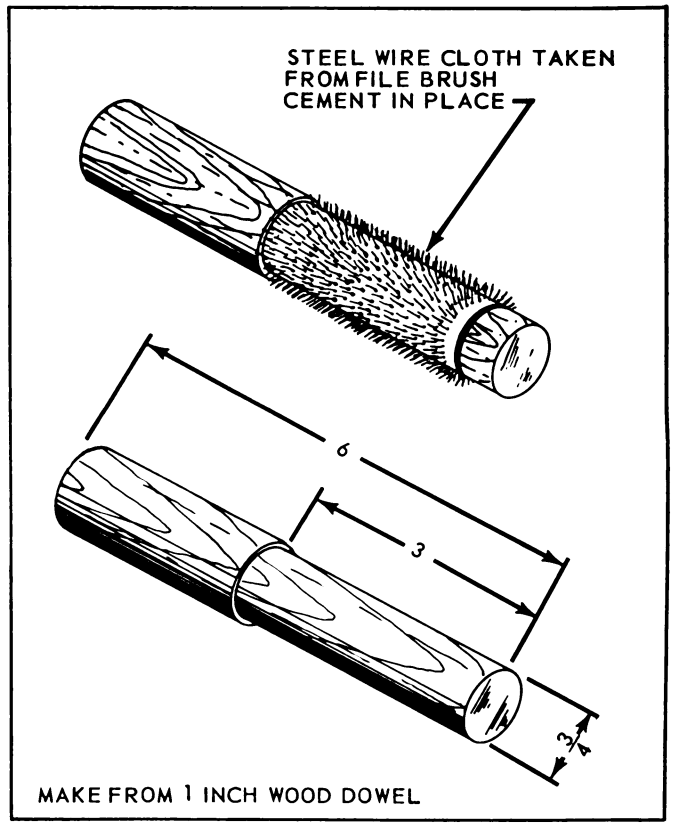


Figure 2–29. Comb for Combing Out Shield

e. Pull empty part of shield taut and tin last inch to prevent fraying.

f. On unjacketed shielded cable, spot tie shielding on cable with clove hitch and square knot. This is not necessary if cable has extruded plastic jacket over shield.

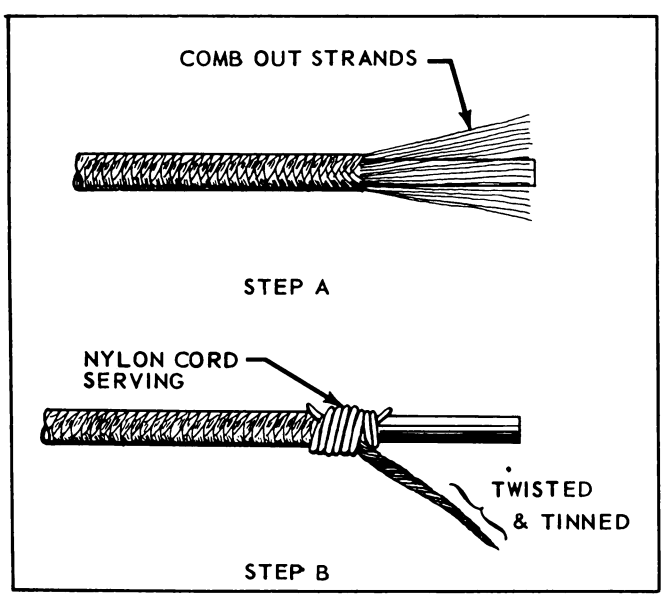


Figure 2–28. Alternate Pigtail Termination for Shielded Wire

2–59. ALTERNATE PIGTAIL METHOD. Some shielding braids may be too stiff for the method described in Paragraph 2–58. In this case, cut shielding with scissors approximately 1-1/2 inches forward of termination point.

Comb out strands with comb (see Figure 2–29) or pointed bakelite rod. Twist strands into pigtail, or separate strands into three parts, twist each part, and braid together. Tie with cord as described in Paragraph 2–58, step f.

2–60. DEAD-ENDING SHIELDED CABLE. When the shielding is not to be grounded, it is dead-ended so as to gather all loose shield ends together to prevent them from puncturing insulation.

2–61. DEAD-ENDING WITH GROUNDING SHEATH CONNECTOR. When equipment is available, dead-end shielded cable with grounding sheath connector as described in paragraph 2–57, omitting ground wire. Refer to Figure 2–26. Omit clearance allowed for ground wire when selecting outer sleeve.

2–62. DEAD-ENDING WITH TAPE WRAP. When grounding sheath connector and tools are not available, dead-end shielding as follows: See Figure 2–30.

a. Cut shielding braid with scissors about 3/4 inch forward of termination point.

b. Loosen braid and turn back on itself 3/4 inch.

c. Wrap with two or three turns of plastic tape, making sure that all braid ends are covered.

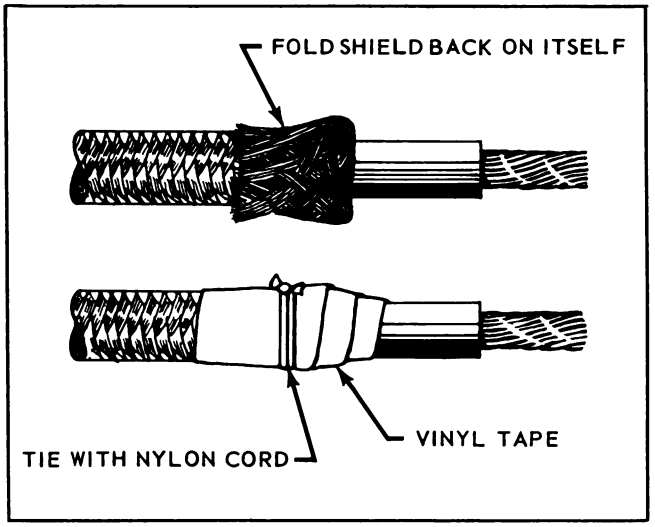


Figure 2–30. Dead Ending Shield With Tape Wrap

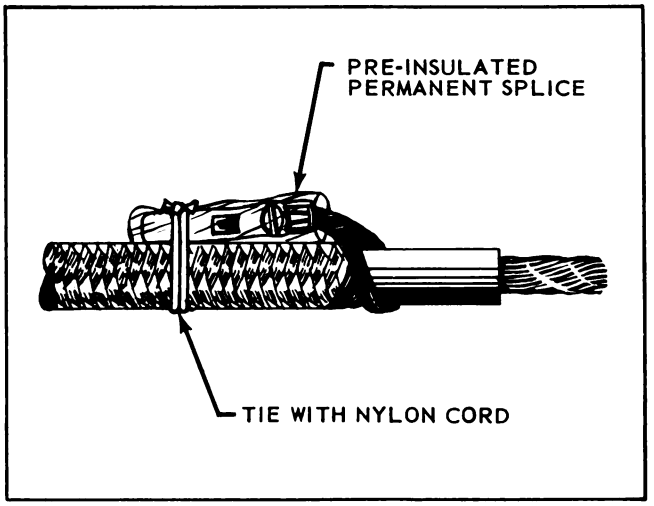


Figure 2–31. Dead Ending Shield With Permanent Splice

d. Tie loose end of tape with clove hitch and square knot, or heat seal end of tape with untinned side of soldering iron.

2–63. ALTERNATE METHODS OF DEAD-ENDING. As alternate to method described in paragraph 2–61, make pigtail as described in paragraphs 2–58 or 2–59, and trim pigtail so it is 3/4 inch long. Crimp trimmed pigtail into one end of preinsulated permanent splice of suitable size, and tie back on shielded part of cable. See Figure 2–31. If permanent splice is not available, cut tongue off solderless terminal of suitable size, and crimp pigtail into it. Protect with sleeve and tie back on wire, similar to tie used with permanent splice.

SECTION III

GENERAL PURPOSE CONNECTORS

3–1. INTRODUCTION.

3–2. GENERAL. Connectors provide means of quickly connecting and disconnecting wires to simplify installation and maintenance of electric and electronic equipment.

3–3. SCOPE. This section describes and illustrates the types and classes of AN and similar connectors (See Figure 3–1) used in aircraft. RF connectors are treated separately in Section IV.

3–4. REFERENCE SPECIFICATIONS, DRAWINGS AND DOCUMENTS.

AN–P-51	Petrolatum
QQ-S-571	Solder, soft; (Tin, Tin-Lead, Lead-Silver)
MIL-T-713	Twine, Lacing and Tying, Electrical and Electronic Equipment
MIL-I-631	Insulation, Electrical, Synthetic-resin composition, non-rigid
MIL-C-5015	Connectors, Electrical, AN Type
MIL-W-5088	Wiring, Aircraft, Installation of
MIL-C-5649	Cord, cotton, braided, pre-waxed
MIL-A-6091	Alcohol, specially denatured Ethyl
MIL-S-6872	Soldering Process, General Specification for
MIL-M-6998	Methylene Chloride
MIL-I-7444	Insulation Sleeving, Electrical, flexible
MIL-S-8516	Sealing Compound, Synthetic Rubber, Catalyzed
Navy-BuAer	Dwg 54A3A224 Plug - Electrical Connectors Straight (For potting)
Navy-BuAer	Dwg 54A3A225 Plug - Electrical Connector (For potting)
Navy-BuAer	EMC No. 89-55 Electric Connector Sealing -

3–5. DESCRIPTION OF CONNECTORS.

3–6. GENERAL DESCRIPTION OF AN CONNECTORS. Each complete AN connector consists of two parts: a plug assembly and a receptacle assembly coupled by means of a coupling nut which is part of the plug assembly. See Figure 3–1.

3–7. The receptacle is usually the "fixed" part of the connector, and is attached to a wall, bulkhead or equipment case. The plug is the removable part of the connector and includes the coupling ring. When the two parts are joined together by the coupling ring, the electric circuit is made by pin-and-socket contacts inside the connector. The "live" or "hot" side of the circuit always has socket (female) contacts. Either the plug or the receptacle may contain the "live" parts of the circuit. The contacts are held in place and insulated from one another and from the shell by an insert. Insert and contacts are housed in a metal shell. See Figure 3–2 for the exploded view of a typical plug. See Figure 3–3 for the exploded view of a typical receptacle.

3–8. AN connectors are separated into types and classes with manufacturers' variations in each type and class. These manufacturers' variations are differences in appearance and in the method of meeting specification requirements. The variations are minor and do not affect the ability to mate plugs and receptacles made by different manufacturers. There are six types of AN connectors as listed in Table X and shown in Figure 3–1. The AN connectors are further separated into five classes as shown in Table XI. Note that not all types are available in each class.

TABLE X

Types of AN Connectors

AN Type	*Nomenclature*
AN 3100	Wall Mounting Receptacle
AN 3101	Cable Connecting Receptacle
AN 3102	Box Mounting Receptacles
AN 3106	Straight Plug
AN 3107	Quick Disconnect Plug
AN 3108	90 Degree Angle Plug

3–9. AN CONNECTOR TYPES. See Figure 3–1. The following six types of AN connectors are used in aircraft:

AN 3100 – a receptacle with flange for mounting to wall or bulkhead. Contains front shell, insert retaining ring, insert, contacts and back shell. See Figure 3–3 for the exploded view of a typical receptacle of this type.

AN 3101 – a receptacle used at the end of a wire or wire bundle where mounting is not necessary. Similar to AN 3100 except that it has no mounting flange.

AN 3102 – a receptacle with flange for mounting to a junction box or equipment case. Similar to AN 3100, except that it has no back shell.

AN 3106 – a straight plug, used at the end of a wire or wire bundle. Consists of front shell, coupling nut, insert retaining ring, insert, contacts and back shell.

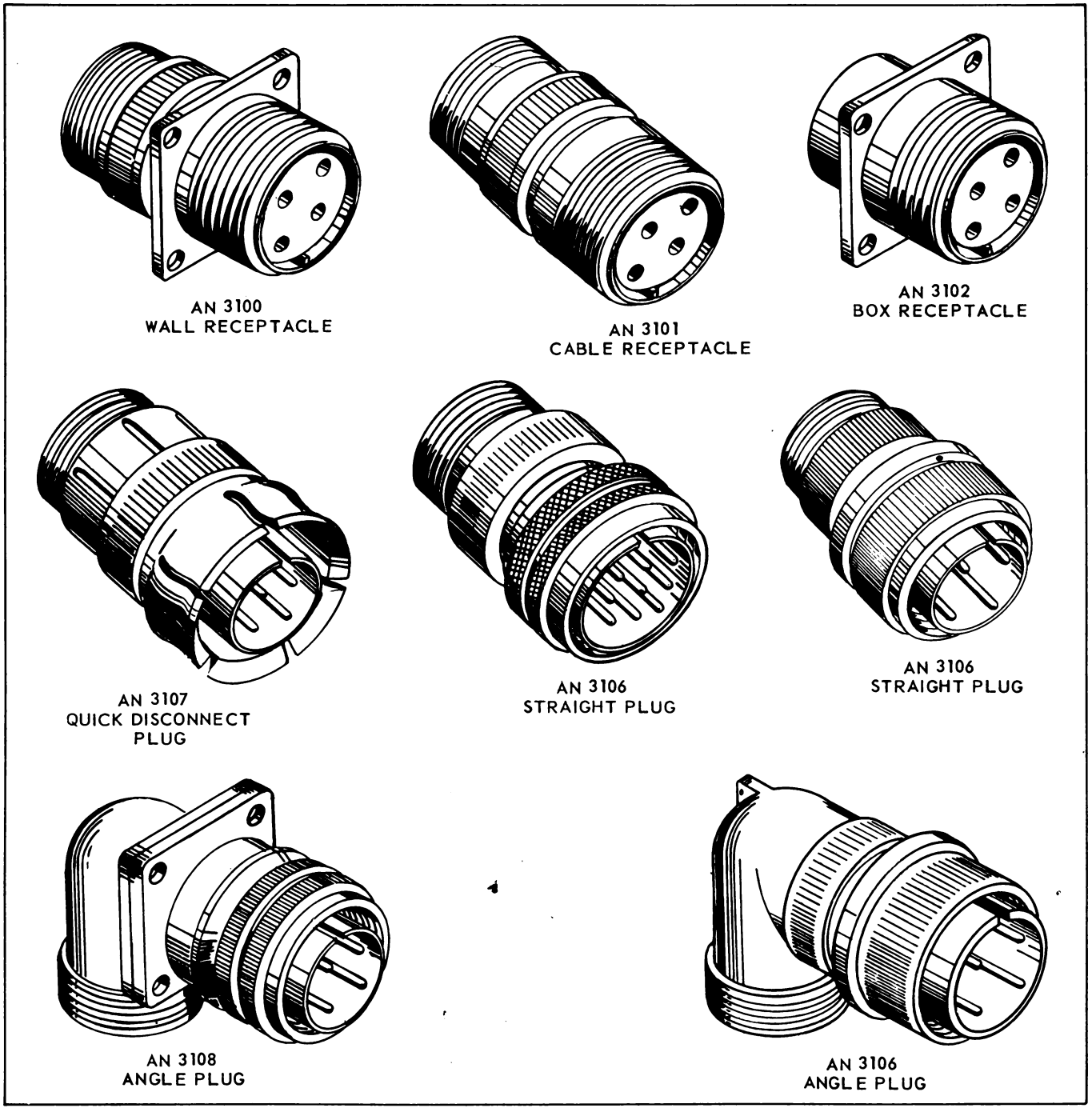


Figure 3–1. "AN" Connectors

TABLE XI

Classes of AN Connectors

AN Class	*Application*	*Shell*	*Availability*					
			3100	*3101*	*3102*	*3106*	*3107*	*3108*
A	General Purpose	Solid Aluminum Alloy	Yes	Yes	Yes	Yes	Yes	Yes
B	General Purpose	Split Aluminum Alloy	Yes	Yes	No	Yes	Yes	Yes
C	Pressurized	Solid Aluminum Alloy	Yes	Yes	Yes	Yes	No	Yes
E	Environmental Resistant	Solid Aluminum Alloy	Yes	Yes	Yes	Yes	No	Yes
K	Fire & Flame Proof	Solid Steel	Yes	No	Yes	Yes	No	Yes

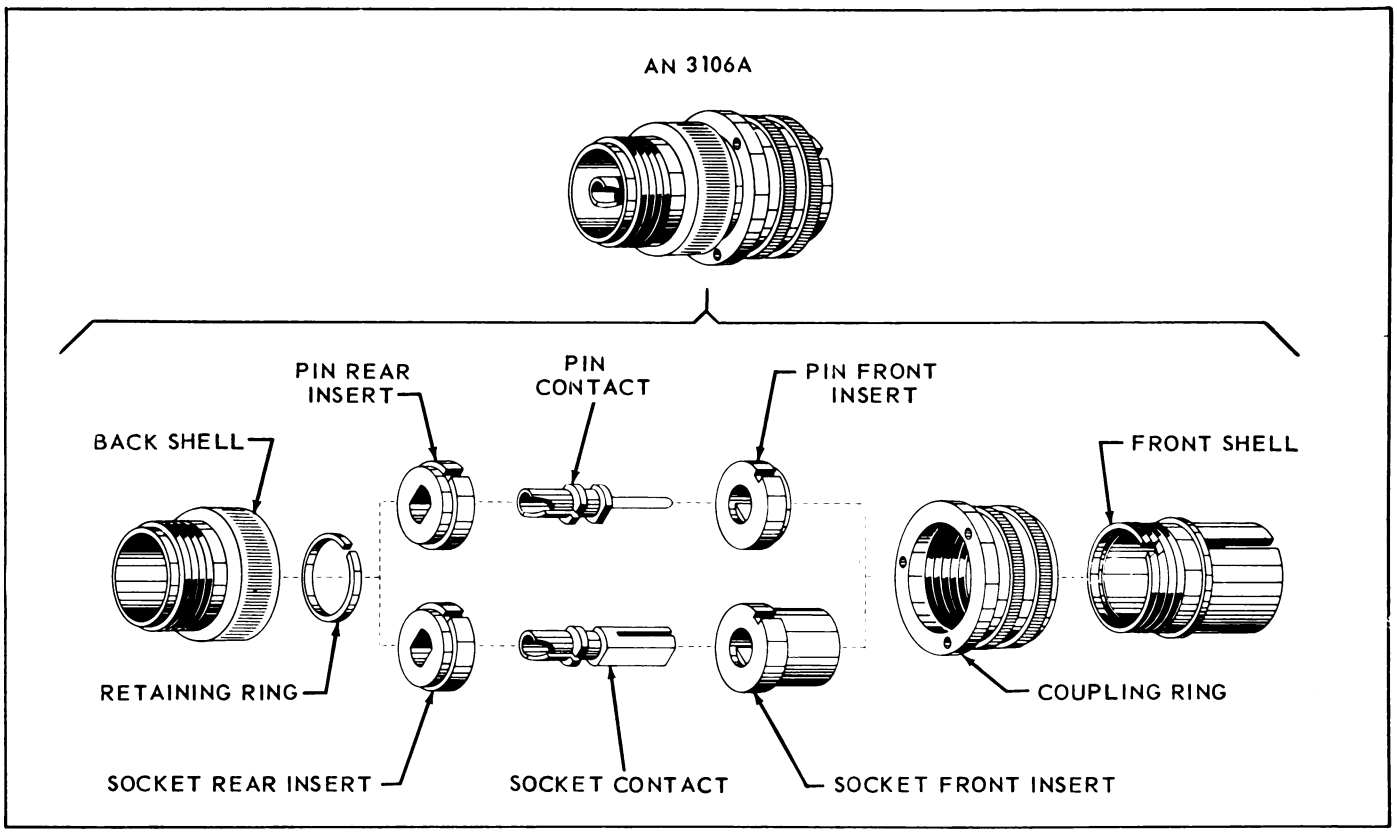


Figure 3–2. "AN" Connector Plug – Exploded View

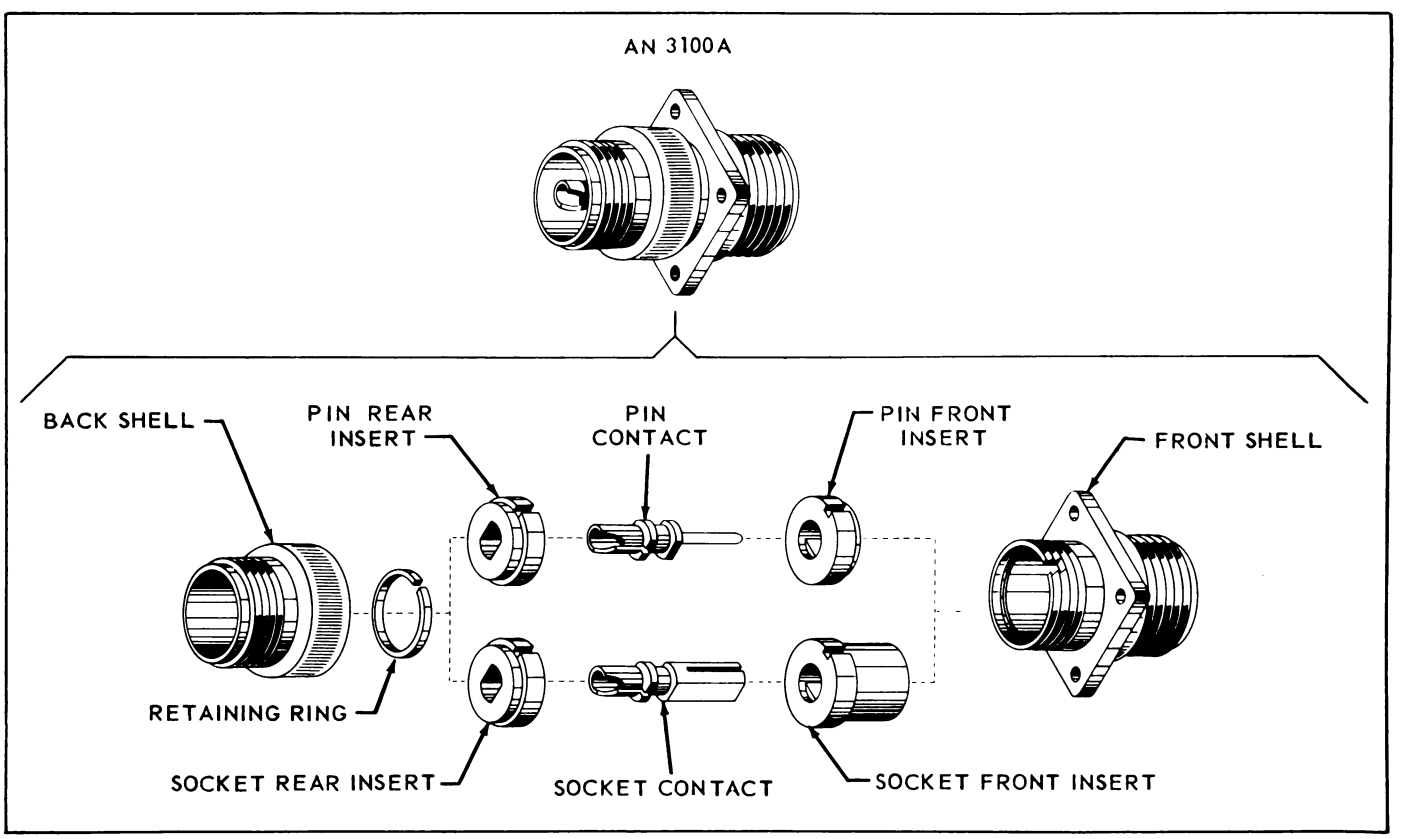


Figure 3–3. "AN" Connector Receptacle – Exploded

See Figure 3–2 for exploded view of a typical plug of this type.

AN 3107 – a "quick-disconnect" plug, used where fast disconnection from the receptacle is necessary. It is similar to AN 3106 except that it is coupled to any AN receptacle by means of friction spring instead of a coupling nut.

AN 3108 – a right-angle plug, used where wiring must make an abrupt change in direction as it leaves the plug.

3–10. AN CONNECTOR CLASSES. There are five classes of AN connectors. All have aluminum alloy shells except Class K which has a steel shell to achieve fire resistance.

Class A – general-purpose connector with solid one-piece back shell. Plugs and receptacles shown in Figure 3–1 are all Class A (solid back shells).

Class B – connector with back shell split in two, lengthwise, used where it is important to be able to get at soldered connections easily. The two halves of the back shell are held together by clamping ring, or by screws. See Figure 3–4 for exploded views of CANNON and AMPHENOL split shell AN connectors.

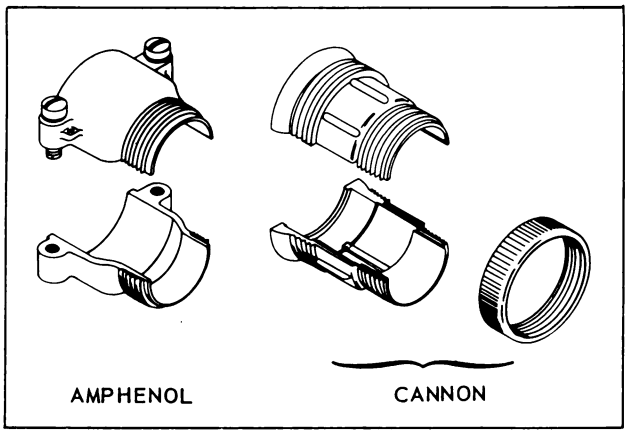


Figure 3–4. Split Back Shells

Class C – pressurized connector, used on walls and bulkheads of pressurized equipment. Externally it looks the same as a Class A connector, but the inside sealing arrangement is sometimes different. Inserts of Class C connectors are not removable.

Class E – environment (moisture and vibration) resisting connector, replacing former Classes F & M, used in areas where quick changes in temperature may cause condensation, or where there is likely to be vibration. Class E connectors have a sealing grommet in the back shell. The wires pass through tight fitting holes in the grommet and are thereby sealed against moisture.

Class K – fireproof connector, used where it is vital that current continue to flow even though the connector may be exposed to continuous open flame. Class K connectors are longer in overall length than other classes, and have a shell made of steel instead of aluminum alloy. Inserts of Class K connectors are of special fire-resistant material, and have crimp-type contacts instead of solder-type.

3–11. AN CONNECTOR MARKING. Each AN connector is marked on the shell or coupling ring with a code of letters and numbers giving all the information necessary to identify the connector. See Figure 3–5.

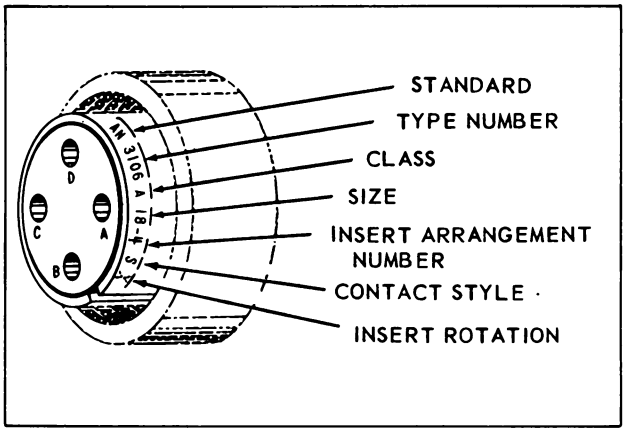


Figure 3–5. "AN" Connector Marking

The code is as follows:

AN3106A–18–4–S––

Plug	Solid Shell	Shell Size	Insert Arrangement	Socket

a. The letters "AN" indicate that the connector has been made according to Government standards, and of a type approved for use by the armed services.

b. Type number such as AN3100, AN3101, etc. indicates type of shell and whether plug or receptacle: Refer to paragraph 3–9.

c. Class letter, such as A (solid shell), C (pressurized), etc. indicates design of shell, and for what purpose connector is normally used. Refer to paragraph 3–10.

d. Size number is the diameter of the coupling thread in sixteenths of an inch. For example, size 20 has a coupling thread of 1-1/4 inches in diameter.

e. Insert arrangement number, indicating a certain arrangement of contacts. The number does *not* give the number of contacts. Charts giving diagrams of these arrangements are available from all connector manufacturers.

f. Contact style letter, indicating whether contacts are pin (P) or socket (S).

g. Insert position, indicating one of several alternate positions to which the insert can be turned. If no letter appears in this location, the insert position is standard as shown on the contact arrangement chart.

3–12. AN CONNECTOR CONTACTS. Sizes of contacts are related to AN wire sizes. Not all wire sizes have corresponding contacts. Contacts accommodate a range of AN wire sizes as given in Table XII.

TABLE XII

AN Connector Contacts

AN Contact Size	*AN Wire Size Range*	*Contact Solder Cup OD Max. (in inches)*	*ID Min. (in inches)*
16	22–16	.130	.069
12	14–12	.170	.112
8	10–8	.255	.205
4	6–4	.370	.328
0	2–0	.550	.464

It is occasionally necessary to use a larger wire than the indicated range. Special instructions are given in paragraph 3–77.

3–13. AN CONNECTOR CABLE CLAMP ADAPTERS. Cable clamp adapters are used at the back end of all AN connectors, except potted connectors, to support wiring, and to prevent twisting or pulling on soldered connections. There are three types of AN cable clamp adapters as shown in Figure 3–6. These are as follows:

a. AN3057 – consists of a clamp body, two washers, and a clamp cap held on the clamp body by two screws and lockwashers.

b. AN3057A – consists of a clamp body and two saddles held on by screws and lockwashers. Used with AN3420 telescoping bushing.

c. AN3057B – one piece clamp with no separate cap or saddles. Used with AN3420A bushings.

NOTE

AN3057 and AN3057A are being replaced, for new designs, by AN3057B, but the older versions are still used in aircraft installations.

3–14. MANUFACTURERS' VARIATIONS IN AN CONNECTORS. The AN electrical connectors most commonly used in aircraft are made by Amphenol, Bendix and Cannon. See Figure 3–7 for external views of variations in appearance.

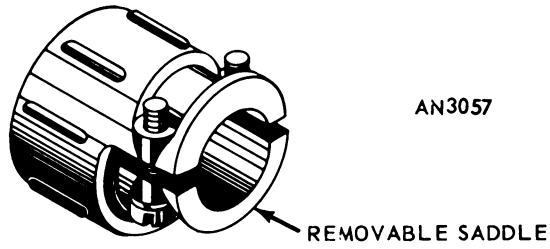


FIGURE 3–6A.

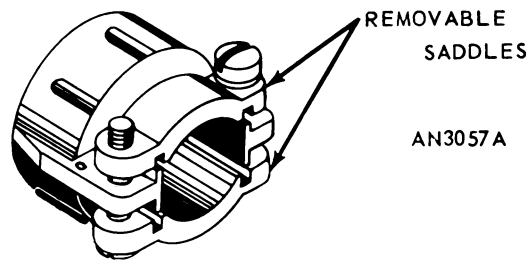


FIGURE 3–6B.

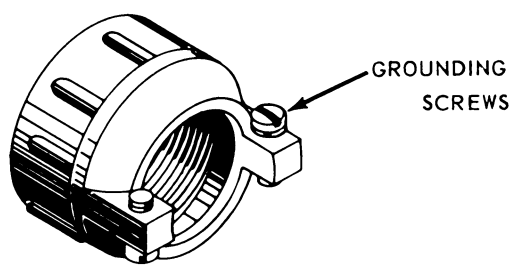


FIGURE 3–6C.

Figure 3–6. AN3057 Cable Clamp Types

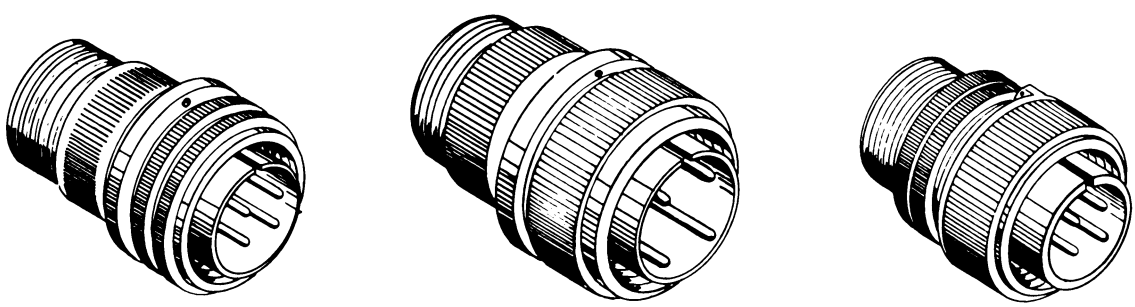


Figure 3–7. Manufacturers' Variations in "AN" Connectors

Plugs or receptacles of one manufacturer will connect with mating plugs or receptacles of any other manufacturer. There are some differences in the appearance of connectors from different manufacturers. The connectors also may require different disassembly instructions. The text and illustrations to follow will show these differences in detail.

3–15. SPECIAL PURPOSE CONNECTORS. In addition to connectors with AN numbers, there are some special connectors commonly used in aircraft, as follows:

a. Numbers 54A3A224 and 54A3A225. See Figure 3–8. These connectors are used only where potting is required: similar to AN types, except they have a shorter body shell or are of split shell construction.

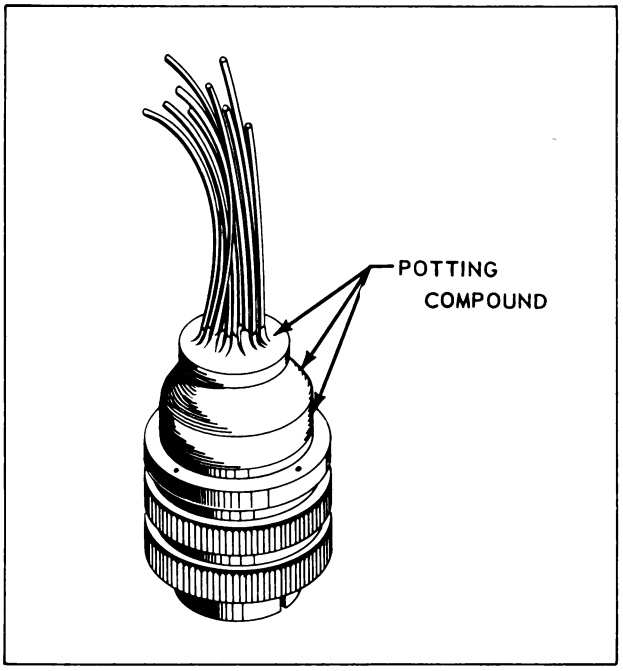


Figure 3–8. Potted Connector

b. Rectangular shell connectors (Cannon DPD type). See Figure 3–9. These are flanged for panel or equipment mounting: consist of aluminum alloy shell, rigid or resilient insert and pin and socket contacts. They are usually potted to protect connections against moisture.

c. Subminiature connectors (Cannon U and Amphenol "26" series). See Figure 3–10. These are wire connecting types only; have no flanges for mounting, but can be mounted with nut and lockwasher; used on miniature instruments, switches, relays, transformers, amplifiers, etc. They consist of steel shell, resilient or vitreous inserts and pin-and-socket contacts. Plug and receptacle are held together by bayonet type lock. Plug has a resilient (silicone compound) sleeve to protect and support wiring. These connectors are always potted to provide moisture proofing.

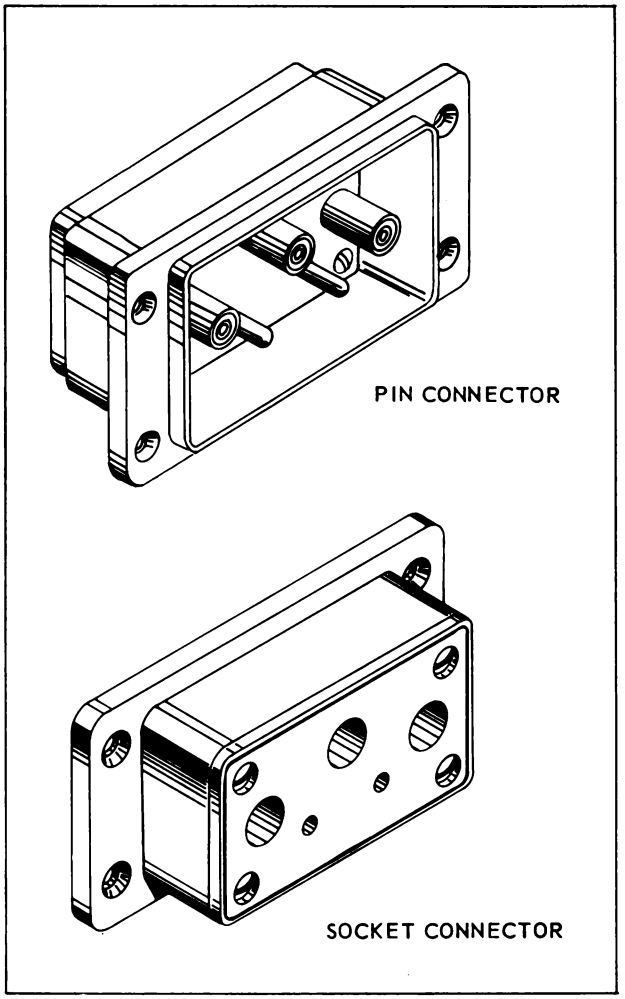


Figure 3–9. Rectangular Shell Connector Cannon DPD

3–16. DISASSEMBLY OF AN CONNECTORS.

3–17. GENERAL. Size 8 and smaller solder-type contacts are usually not removed for assembly purposes. Size 4 and larger solder-type contacts and all sizes of crimp-type contacts are removed for assembly of wires to connectors. Large solder contacts must be removed to protect the insert against the large amount of heat needed to properly solder wire to contact. Crimp-type contacts are removed to enable the contact and wire assembly to be inserted into a crimping tool. Detailed instructions for disassembly of each AN connector variation is given in the following paragraphs. Because of the differences in connectors made by the three major manufacturers, the detailed disassembly instructions are given separately for each manufacturer where necessary.

3–18. REMOVAL OF BACK SHELLS. Remove back shells, if present, from all connectors before attaching wires. Solid back shells of Classes A, C and K are removed by unscrewing from the front shell as shown in Figure 3–11.

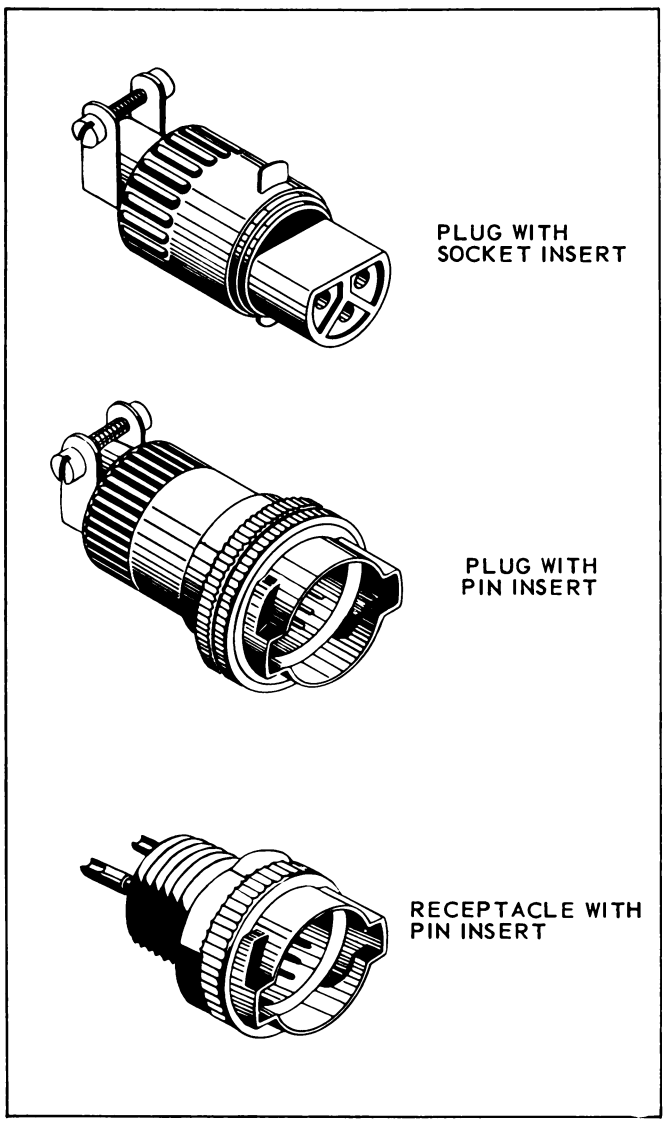


Figure 3–10. Sub-Miniature Connector

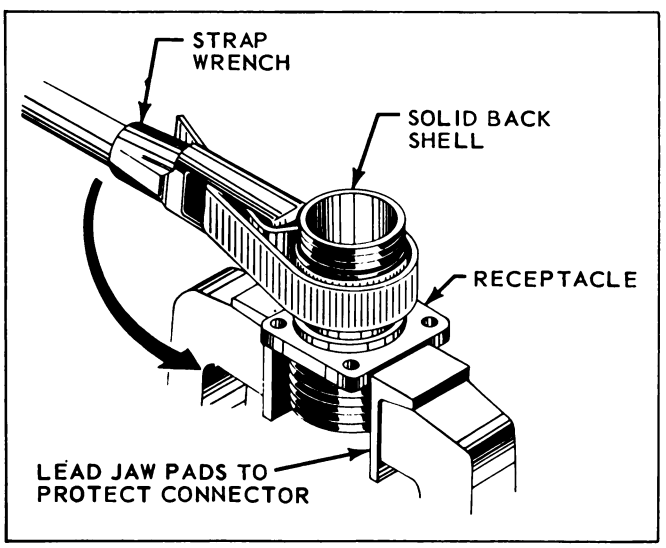


Figure 3–11. Removal of Solid Back Shell

NOTE

Amphenol Class K (fireproof) connectors have no separate back shells. Cannon Class K connectors have no separate back shells in sizes 18 and smaller.

Split back shells of Class B connectors are held together either by an assembly ring or by captive screws. See Figure 3–12 for details of disassembly.

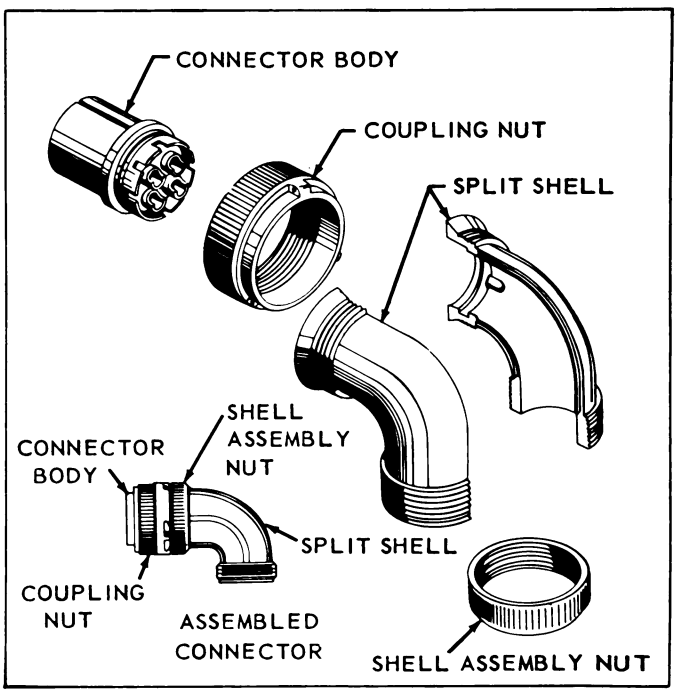


Figure 3–12. Removal of Cannon Split Back Shell

Class E connectors have a special disassembly technique which is described in later paragraphs.

3–19. REMOVAL OF CONTACTS. Size 4 and 0 solder-type contacts are removed before soldering. Size 8 contacts may be removed if close spacing makes it difficult to solder.

CAUTION

Avoid removing contacts from Class C (pressurized) connectors. Amphenol Class C pin contacts size 4 and 0 are threaded into the insert and can therefore be removed safely. *Never* remove *inserts* from Class C connectors.

Solderless contacts such as supplied in Class K must be removed in order to crimp wire into contact. Contacts are removed by the following procedures:

a. Cannon spring clip contacts (see Figure 3–13) are removed by prying off the clip using a small screw divrer or scriber. Rotate contact 90° and lift out.

b. Amphenol two piece inserts have contacts which are held in place by the insert halves. See Figures

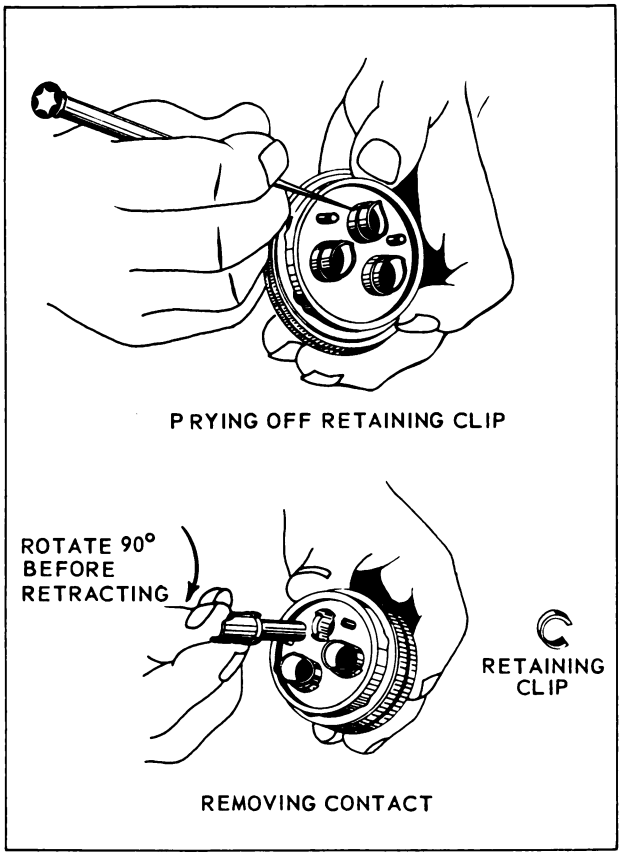


Figure 3–13. Removal of Cannon Clip Held Contacts

3–14 and 3–15. Pry out retaining ring which holds insert in place using small screw driver. Remove inserts and separate them. This will free contacts.

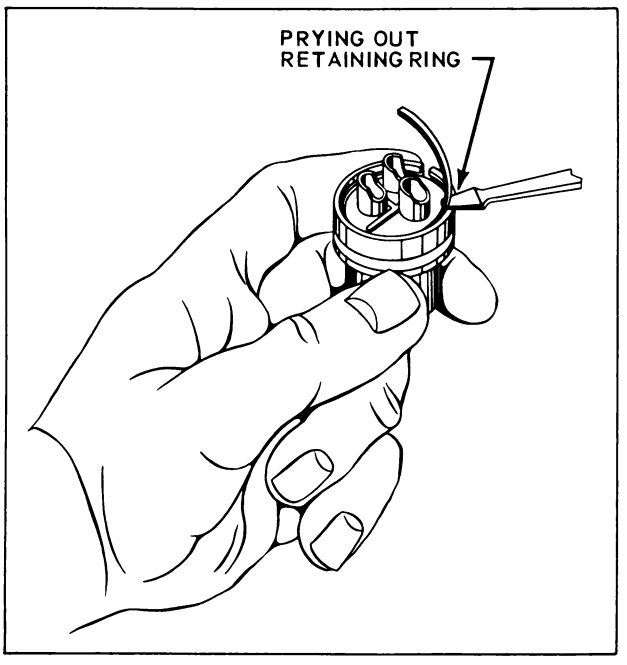


Figure 3–14. Removal of Amphenol Insert Assembly

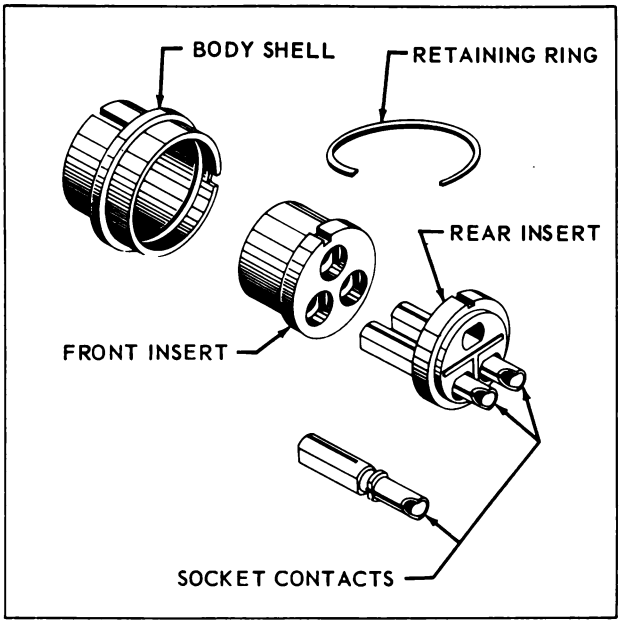


Figure 3–15. Amphenol Contact and Insert Assembly – Exploded View

c. Bendix and Cannon use some resilient inserts. Contacts are removed from these resilient inserts by pushing against the solder cup end with a round phenolic (bakelite) rod a little smaller in diameter than the solder cup. An arbor press, as shown in Figure 3–16, is helpful in removing large size contacts.

CAUTION

Never use pliers to remove contacts. This may damage the contact.

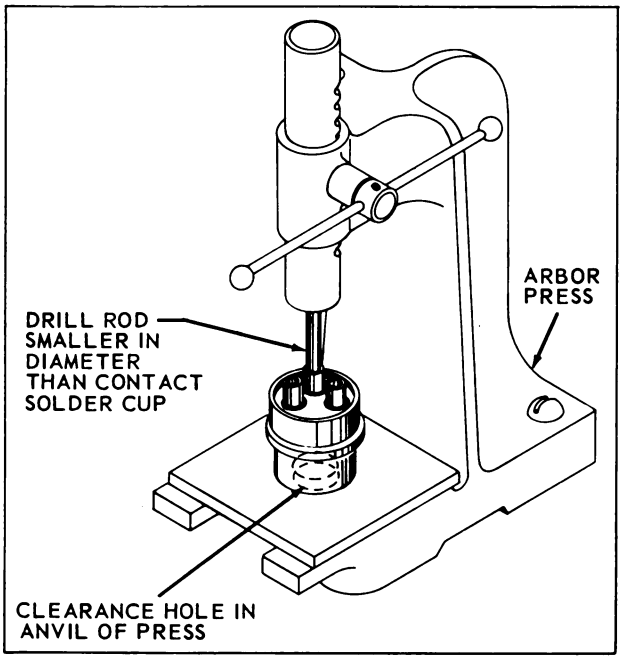


Figure 3–16. Removal of Contacts from Resilient Insert

3–20. SPECIAL DISASSEMBLY INSTRUCTIONS FOR AN CLASS E CONNECTORS. Class E (environment-resisting) connectors are made in two forms. Those made by Bendix have a separate cable clamp similar to AN 3057B (See Figure 3–17). Those made by Cannon use a special cable clamp which is part of the back shell (see Figure 3–18).

3–21. Disassembly of a Bendix Class E connector is accomplished as follows:

a. Unscrew cable clamp from back shell, using strap wrench if necessary.

b. Remove tapered sleeve (grommet retainer) and grommet from back shell.

c. Unscrew back shell from body assembly using strap wrench if necessary.

d. Remove contacts size 8 and larger as described in paragraph 3–19c.

3–22. Disassemble Class E connectors made by Cannon as follows:

a. Remove cable clamp saddle by removing two screws.

b. Unscrew back shell from body assembly, using strap wrench if necessary.

c. Remove AN 3420 telescoping bushing(s).

d. Remove grommet follower (grommet retainer) and grommet.

e. Remove contacts size 8 and larger as described in paragraph 3–19c.

NOTE

Cannon AN 3108E moisture-proof right angle plug has cable clamp separate from back shell (similar to Bendix Class E). Remove cable clamp and telescoping bushing(s) before unscrewing back shell.

CAUTION

Do not remove inserts of moisture-proof connectors. Removal will destroy the moisture-proofing. Do not remove contacts smaller than size 8 except for replacement.

3–23. SPECIAL DISASSEMBLY INSTRUCTIONS FOR CANNON DPD CONNECTORS. Cannon DPD connectors are used in special installations, usually where it is necessary to simultaneously disconnect coaxial cables and general AN wires. DPD connectors are disassembled as follows:

a. Remove four self locking nuts.

b. Lift away coaxial contact and insert retainer clips.

c. Pull out coaxial contacts from rear of insert.

d. Insert is then removed from front of body.

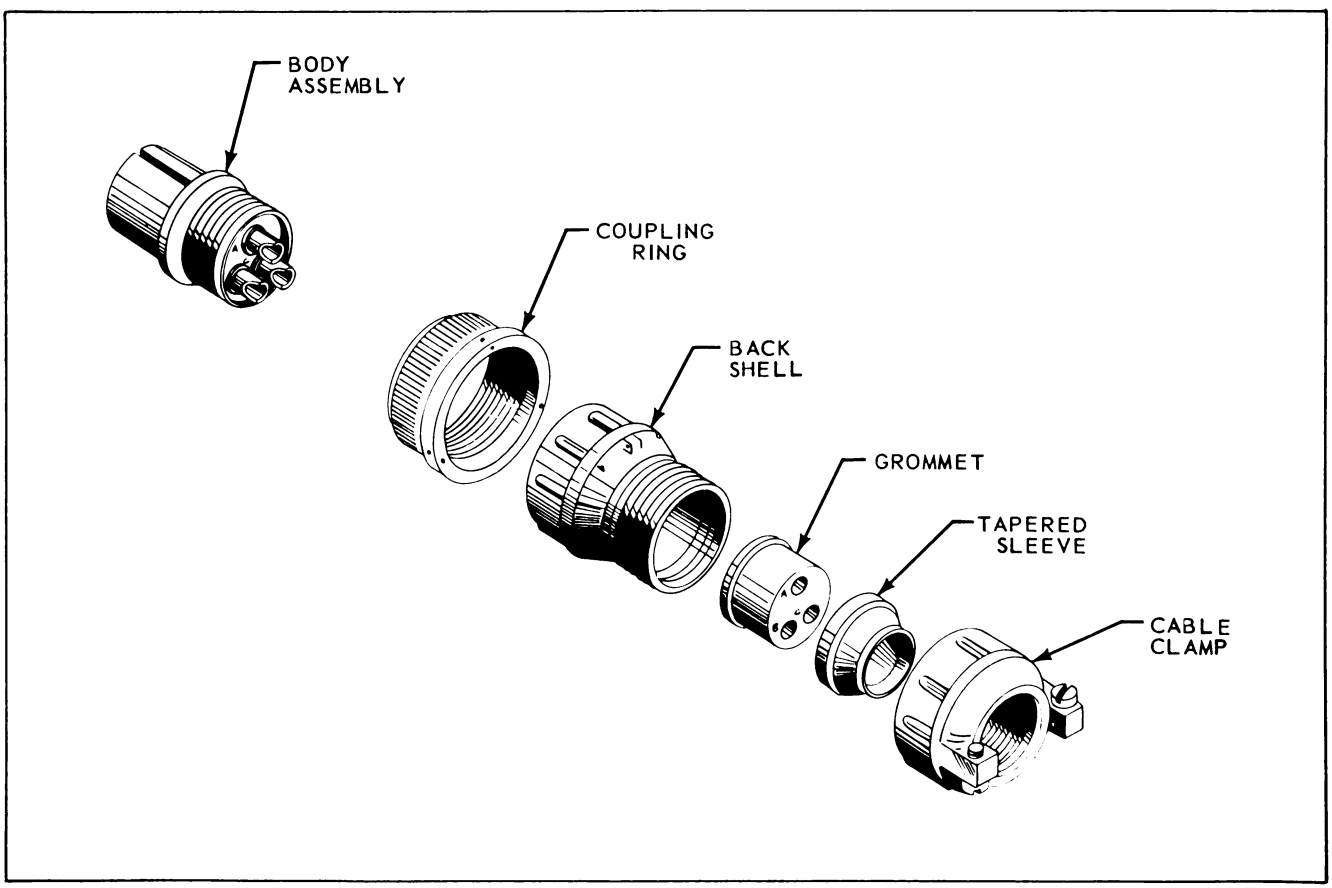


Figure 3–17. Class E Connector – Bendix – Exploded View

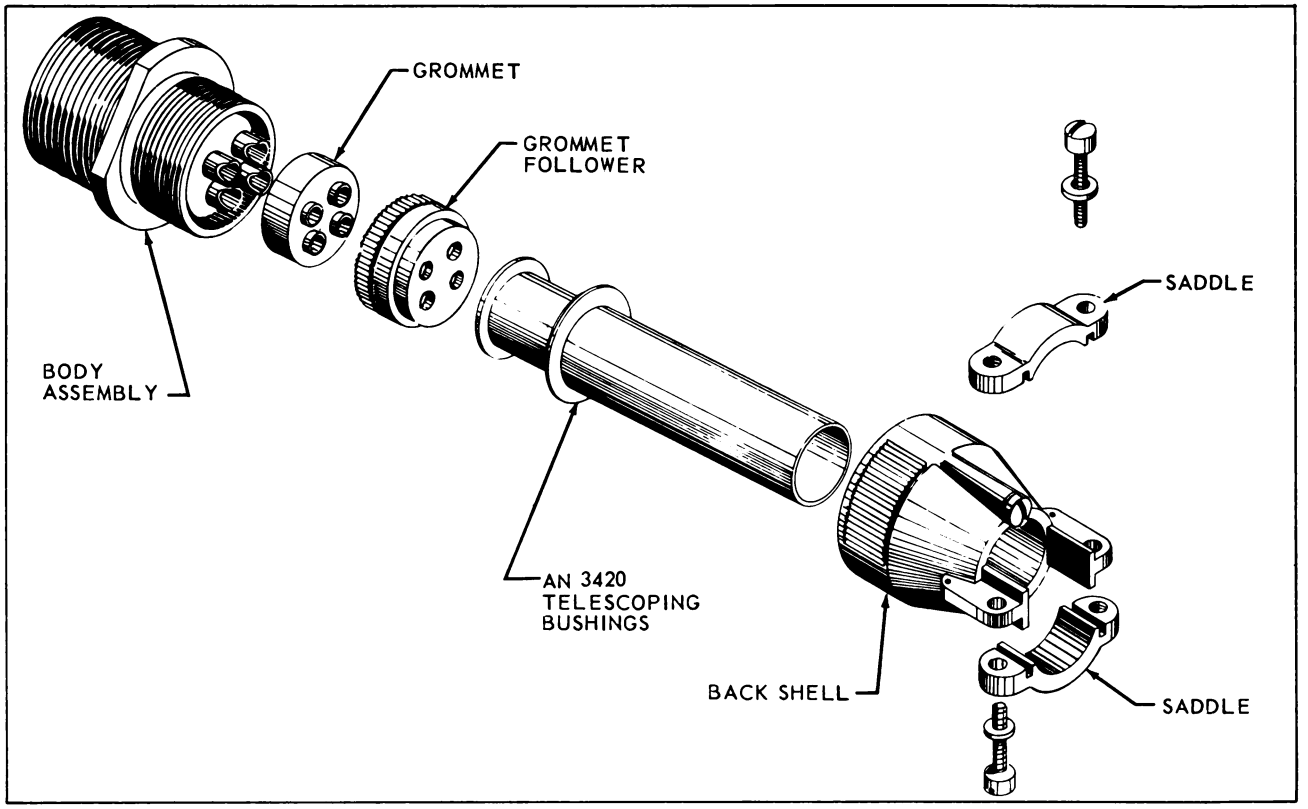


Figure 3–18. Class E Connector – Cannon – Exploded View

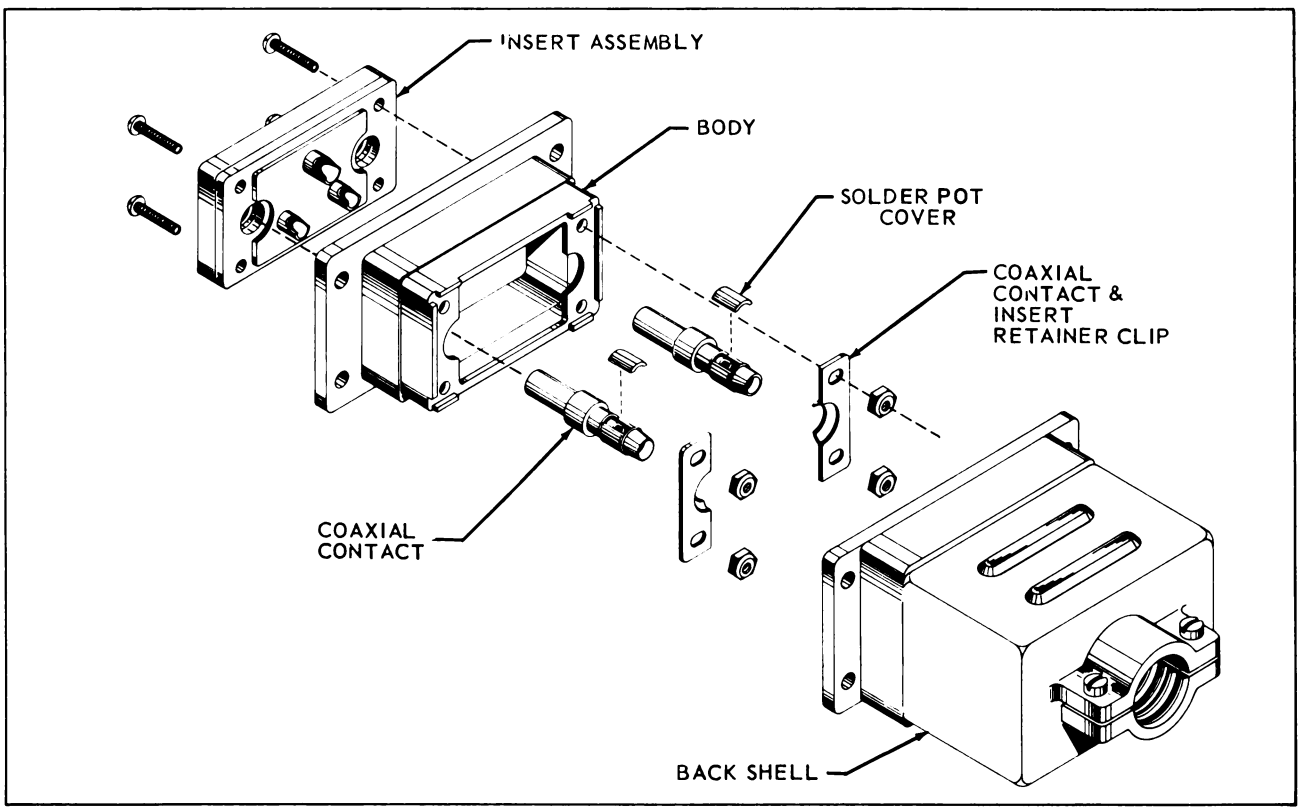


Figure 3–19. Rectangular Shell Connector – Cannon DPD – Exploded View

3–24. SUBMINIATURE CONNECTOR DISASSEMBLY. Cannon "U" and Amphenol "26" series connectors are subminiature. Pin contacts are fused into vitreous insulation and are not removable. Socket contacts are sealed into resilient silicone rubber and are also not removable. The cable ring, outer shell, and silicone rubber sleeve are removed and threaded over the wire bundle in that order before connections are soldered. See Figure 3–20 for exploded view of this connector.

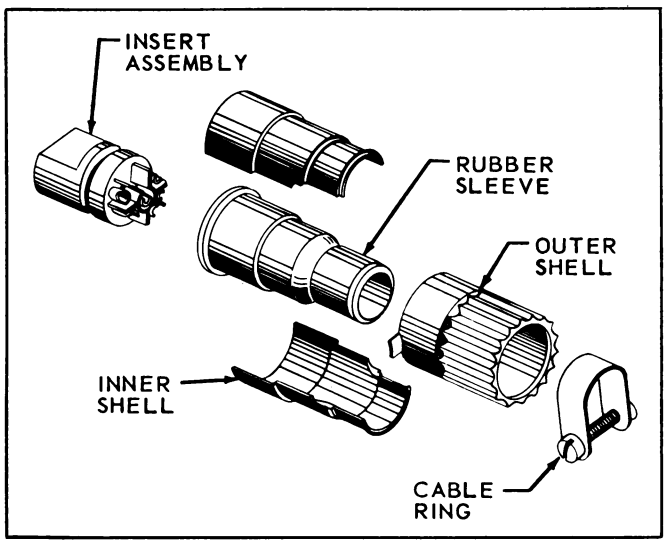


Figure 3–20. Subminiature Connector – Exploded View

3–25. ASSEMBLY OF WIRES TO CONNECTORS.

3–26. WIRE TYPES. Five types of wire and cable are normally fastened to these connectors. These are:

a. Tin-coated copper wire (MIL-W-5086, MIL-W-5274)
b. Silver-coated copper wire (MIL-W-7139)
c. Nickel-clad copper wire
d. Coaxial cable (JAN-C-17)
e. Thermocouple wire:

Chromel-alumel (MIL-W-5846)
Iron-constantan (MIL-W-5845)

The choice of wire is controlled by the installation and is indicated on the engineering drawing.

CAUTION

Do not substitute one wire type for another without engineering approval.

3–27. SOLDERS. Solders and other fastening means are matched to the wire type and to the installation as follows:

a. Soft solder, – 60/40 tin-lead (Federal Specification QQ-S-571, composition Sn 60) is used for tin-coated copper wire and for coaxial cable.

b. Soft solder, – lead-silver (Federal Specification QQ-S-571, composition Ag 2.5 or Ag 5.5) is used for silver-coated copper wire.

c. Crimp connections are used for nickel-clad copper wire.

d. Thermocouple wires require special procedures which are detailed in Section VI.

3–28. CONTACTS. Contacts are supplied in two types:

a. Solder cup – for all connectors except Class K (fireproof).
b. Crimp – for Class K (fireproof) connectors.

Solder cup contacts are silver or gold plated to provide low contact resistance. Silver plated contacts have pre-tinned solder cups. Gold plated contacts are not pre-tinned because the gold prevents oxidation and is therefore always easy to solder.

3–29. PREPARATION OF WIRES BEFORE ASSEMBLY. The preparation of wires before assembly is as follows: (See Section II)

a. Cut wire to prescribed length.
b. Identify wire with proper coding.
c. Strip ends to the following dimensions for soldered connections:

TABLE XIII

Stripping Lengths For Solder Connections

Contact Size	*Stripped Length (inches)*
16	5/16
12	7/16
8	9/16
4	3/4
0	7/8

d. Strip ends to the following dimensions for crimped connections:

TABLE XIV

Stripping Lengths For Crimp Connections

Contact Size	*Wire Size (AN)*	*Stripped Length (inches)*
16	16, 18 & 20	5/16
12	12 & 14	5/16
8	8	9/16

NOTE

#22 wire can be crimped into #16 contact provided the #22 wire is stripped to 5/8 inches and doubled back on itself.

e. Tin wires which are to be soldered to contacts.

CAUTION

Do *not* tin wires which are to be crimped to contacts.

The procedures for the above steps are described in detail in Section II – Wire Preparation.

3–30. INSULATING SLEEVES. Insulating sleeves are used over soldered connections to help protect the connection against vibration and to lengthen the arc-over path between contacts. Insulating sleeves are not used under the following conditions:

a. Insulating sleeves are *not* used when connectors are to be moisture-proofed by potting.

b. Insulating sleeves are *not* used in Class E connectors made by Cannon, because the sealing grommets cover the solder connection.

NOTE

Class E moisture proof connectors made by Bendix need insulating sleeves, because the grommets do not cover the soldered connection.

3-31. SELECTION OF INSULATING SLEEVES. Select insulating sleeving from the materials listed in Table XV to suit the temperature conditions in the place where the connector will be installed.

TABLE XV

Insulating Sleeving Material

Temperature Range	*Material*	*MIL Spec.*
Up to 160°F	Vinyl, transparent	MIL-I-7444 or MIL-I-631
	Nylon, transparent	
160°F-400°F	Silicone-impregnated fiber-glass	MIL-I-3190
	Silicone-rubber fiber-glass	---
400°F-600°F	Extruded Teflon	---
	Teflon-impregnated fiber-glass	---

Select the proper size from Table XVI, so that the inside diameter of the sleeving will fit snugly over the solder cup.

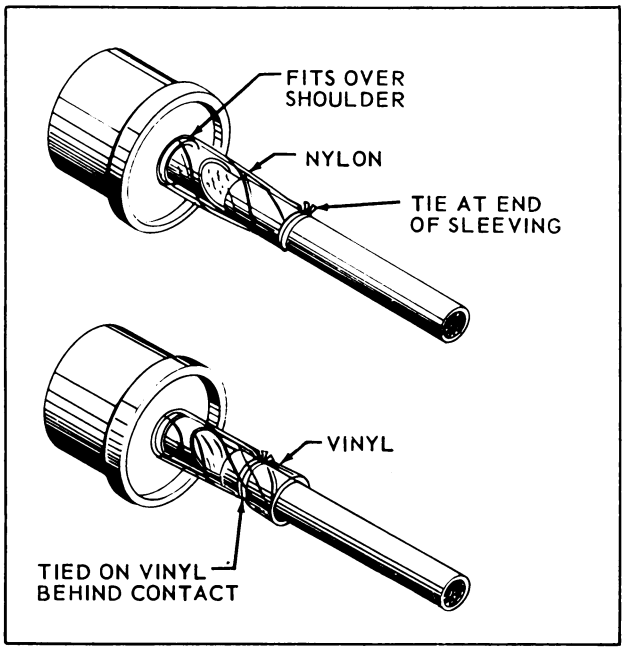


Figure 3-21. Insulating Sleeving Installed Over Solder Cup

TABLE XVI

Insulating Sleeving Sizes

AN Wire Size	*Insulating Sleeving*		
	Number	*I.D.*	*Length*
		(in inches)	
16-14	7	.148	3/4
12	5	.186	3/4
10	3	.234	3/4
8	1	.294	1
6	0	.330	1-1/4
4	7/16	.438	1-1/4
2	1/2	.500	1-1/4
0	5/8	.625	1-1/4

3-32. INSTALLATION OF INSULATING SLEEVES. Cut the sleeving into lengths, as given in Table VIII, to cover the soldered connection completely from the insert to a little over the wire insulation - See Figure 3-21. Slip insulating sleeve of correct size, material and length over each prepared wire, far enough back from the stripped end to avoid heat from soldering operation (about one inch).

3-33. SOLDERING PROCEDURE. Wires are soldered to contacts by use of a soldering iron, a torch, or by resistance heating. A good mechanic knows that safe connections are the result of clean parts carefully soldered together. The following points should be observed in all soldering:

a. Use only enough solder to make a good joint.

b. Solder has no mechanical strength. Do not depend on solder to keep a wire from pulling out of a contact. Use cable clamp or potting to give mechanical strength.

c. Joints with thick layers of solder are likely to be porous or cold.

d. Do not move connection until solder has hardened.

e. A poorly tinned wire or contact cannot result in a safe soldered connection.

f. Use only rosin or rosin-alcohol as a flux for soldering wires to contacts.

CAUTION

Never use any paste flux for soldering in an electrical or electronic connector.

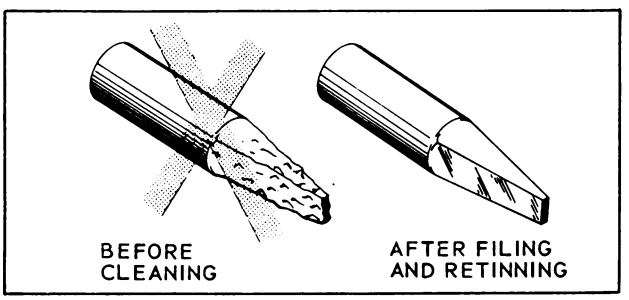


Figure 3-22. Soldering Iron Tip Before and After Cleaning

g. Keep soldering iron clean and free from oxides. Wipe tip with heavy cloth to remove burnt flux. Use smooth flat file to reshape tip as it becomes pitted. This will provide a clean, smooth surface for best heat transmission. See Section IV, paragraph 4-27 for detailed instructions on soldering iron maintenance.

NOTE

Some soldering iron tips are coated with pure iron which resists oxidation. These tips must *not* be filed or ground down.

h. Keep electrical resistance pliers clean and free from flux and solder splatter. Use a brass wire brush, by hand, to clean contacting surfaces.

i. Copper soldering iron tips should be chosen so that the shape will provide good heat transfer. A large contact area touching the solder cup will aid in producing a good connection quickly. See Figure 3-23 for suitable iron tips.

j. Use an iron of proper wattage. An iron with excessive heat capacity will burn or melt the insert or the wire insulation. Too little heat capacity will make a "cold" joint in which the solder does not alloy with the wire and the contact. A good joint with a

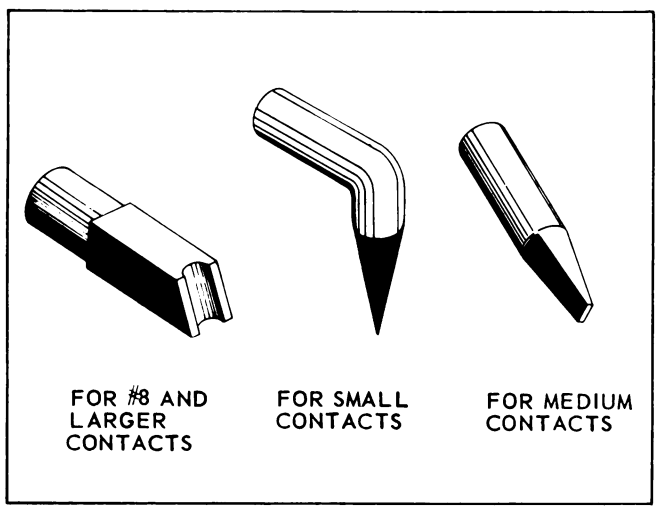


Figure 3-23. Soldering Iron Tip Shapes

smooth fillet is shown in Figure 3-24a. A poor joint "cold" soldered with a gray granular structure is shown in Figure 3-24b. The poor joint must be disassembled, the parts retinned and the joint remade using sufficient heat.

3-34. ELECTRICAL RESISTANCE SOLDERING. Resistance soldering will yield excellent results for both very large contacts and very small contacts.

a. Large contacts are soldered to wires by use of resistance soldering pliers. See Figure 3-25. The contact, removed from insert, is held in the jaws of the pliers and current is applied until the solder in the solder well has melted. Then the pre-tinned wire is inserted slowly into the solder cup while current is

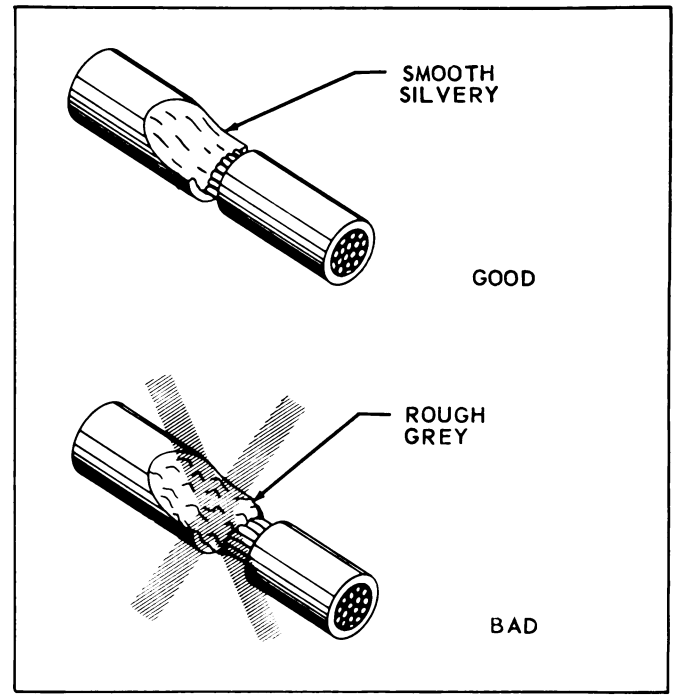


Figure 3-24. Good and Bad Soldered Connections

still being applied. After the wire is fully inserted, continue heating until the solder flows to form smooth fillet. Allow joint to cool and harden without movement.

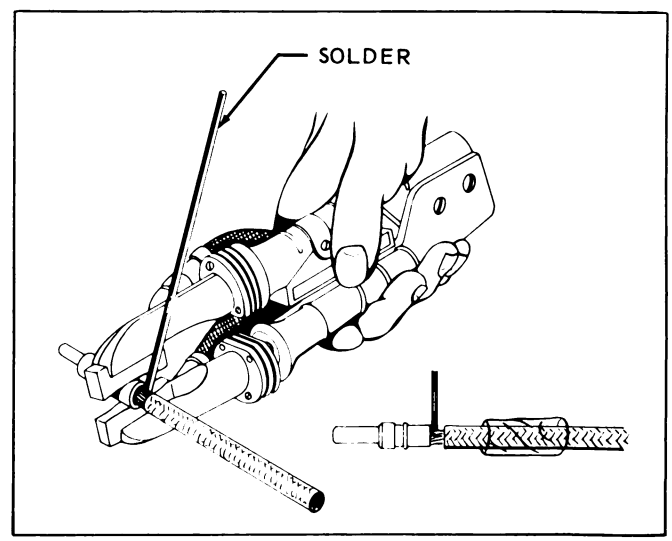


Figure 3-25. Resistance Soldering Pliers for Large Contacts

b. Small contacts (such as in Cannon "U" series) are heated for soldering by use of pencil type resistance soldering tool shown in Figure 3-26. The two electrodes of the tool are placed in contact with the side of the solder cup so that the heating current will pass through the wall of the cup. When the solder in the cup flows, insert the pre-tinned wire. Continue to apply heat to connection until solder flows to form smooth fillet, then stop current and allow joint to cool without movement.

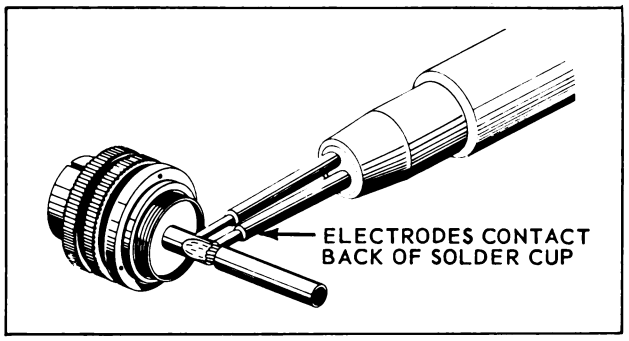


Figure 3–26. Resistance Soldering Pencil for Small Contacts

3–35. TORCH SOLDERING. A torch can be used to solder wire into a large contact which has been removed from its insert.

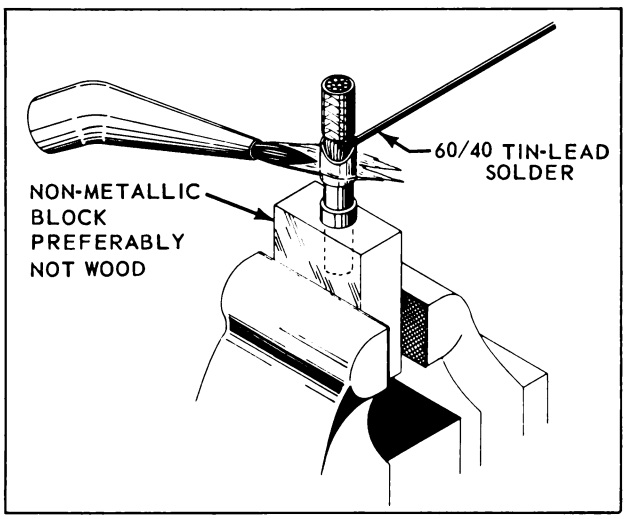


Figure 3–27. Torch Soldering Large Contact

The contact is held in a non-metallic block to avoid heat loss, and the torch is played over the solder cup area until the solder in it melts.

CAUTION

Do not overheat. Excessive heat will destroy the plating and also soften the contact.

When the solder in the cup has melted, insert the wire slowly into the cup and add more 60/40 rosin-core solder if necessary. Continue to heat the connection until the solder flows into a smooth fillet then remove the flame. Allow the joint to cool without movement.

3–36. SOLDERING IRON PROCEDURE. Soldering with an electrically heated iron is the most common procedure. For convenience either the iron or the connector is fastened to the bench as described in paragraph 3–37. Soldering is accomplished as follows:

a. Large contacts which have been removed from inserts are held in a non-metallic block and soldered by first heating the solder cup with the specially

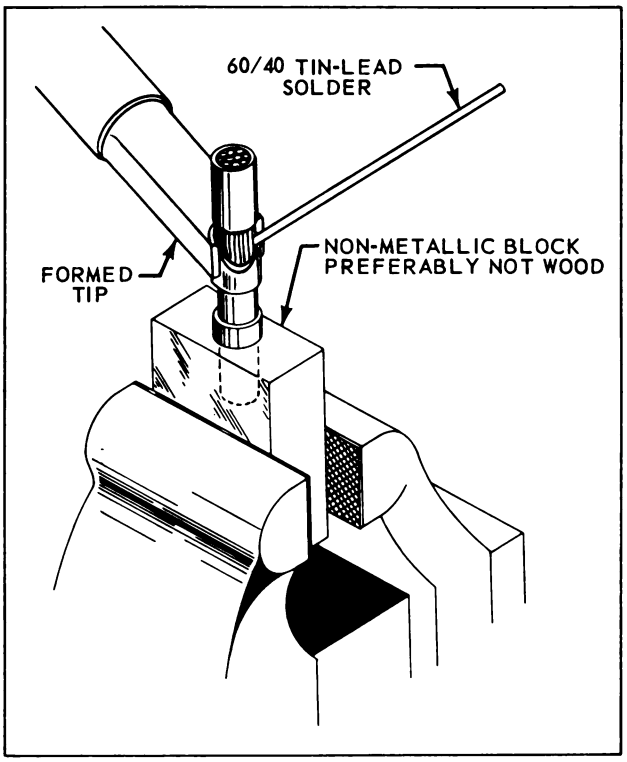


Figure 3–28. Soldering Large Size Contact

shaped tip as shown in Figure 3–28. Then while heat is still applied, the pre-tinned wire is slowly inserted into the solder cup until it bottoms. Extra 60/40 rosin-core solder is added to the solder cup if necessary. Hold the hot iron to the solder cup until the solder has flowed into a smooth fillet then allow to cool.

CAUTION

Do not keep the hot iron against the solder cup longer than necessary because this will force solder up into the conductor where it will stiffen the wire. Stiff wires will break when vibrated.

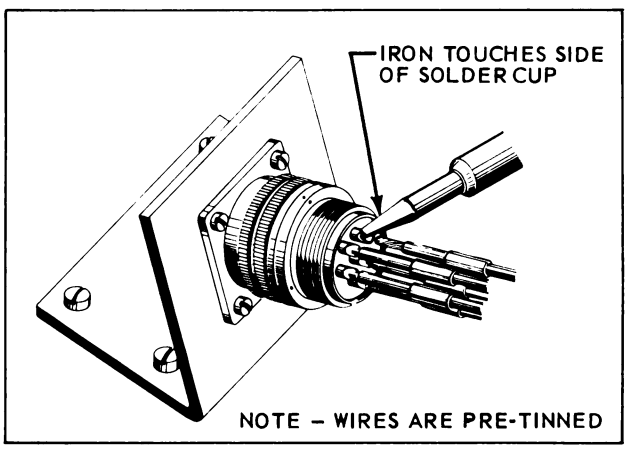


Figure 3–29. Soldering Small Size Contacts

b. Contacts which have not been removed from inserts are soldered as shown in Figures 3–29 and 3–30. The solder is flowed by placing the iron alongside the solder cup as the wire is being inserted into it. Medium size contacts such as #8 and #12 will solder easier if the iron is held at the point where the wire touches the cutaway of the solder cup as shown in Figure 3-30. Adding a small quantity of 60/40 rosin-core solder at this point will aid in carrying the heat into the joint.

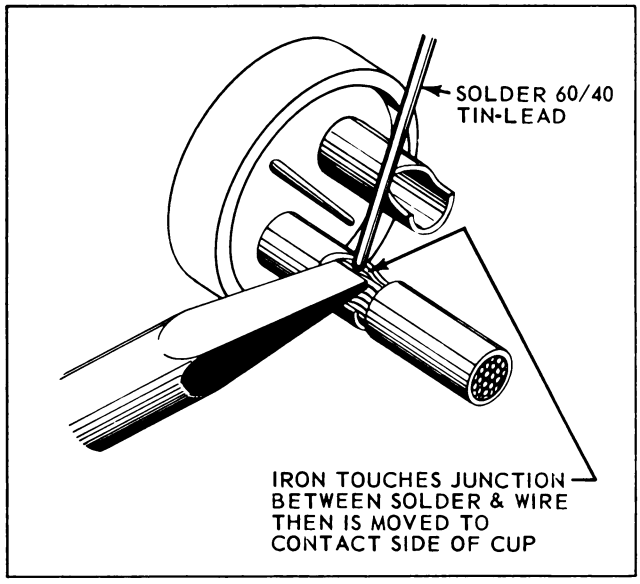


Figure 3–30. Soldering Medium Size Contacts

CAUTION

Do not allow solder to collect outside of the solder cup. This will reduce the arc-over distance between contacts and can result in connector failure.

3–37. HOLDING CONNECTORS FOR SOLDERING. To facilitate soldering wires to contacts which have not been removed from connectors, it is helpful to either work to a fixed soldering iron or to fasten the connector into a holding fisture. If the iron is fastened to the bench, secure it into a safety screen such as

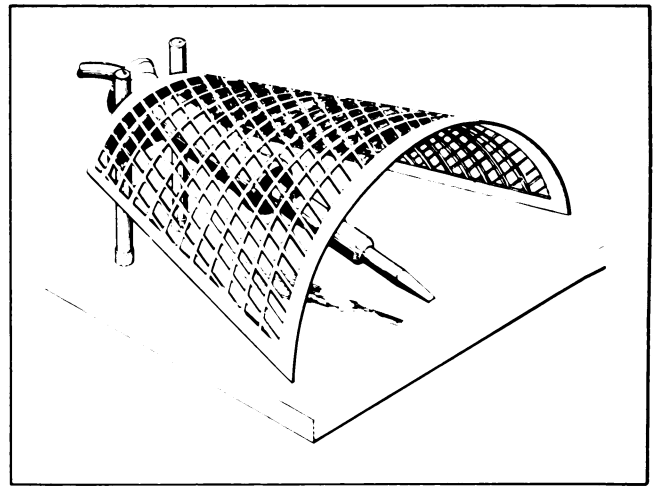


Figure 3–31. Soldering Iron in Safety Screen

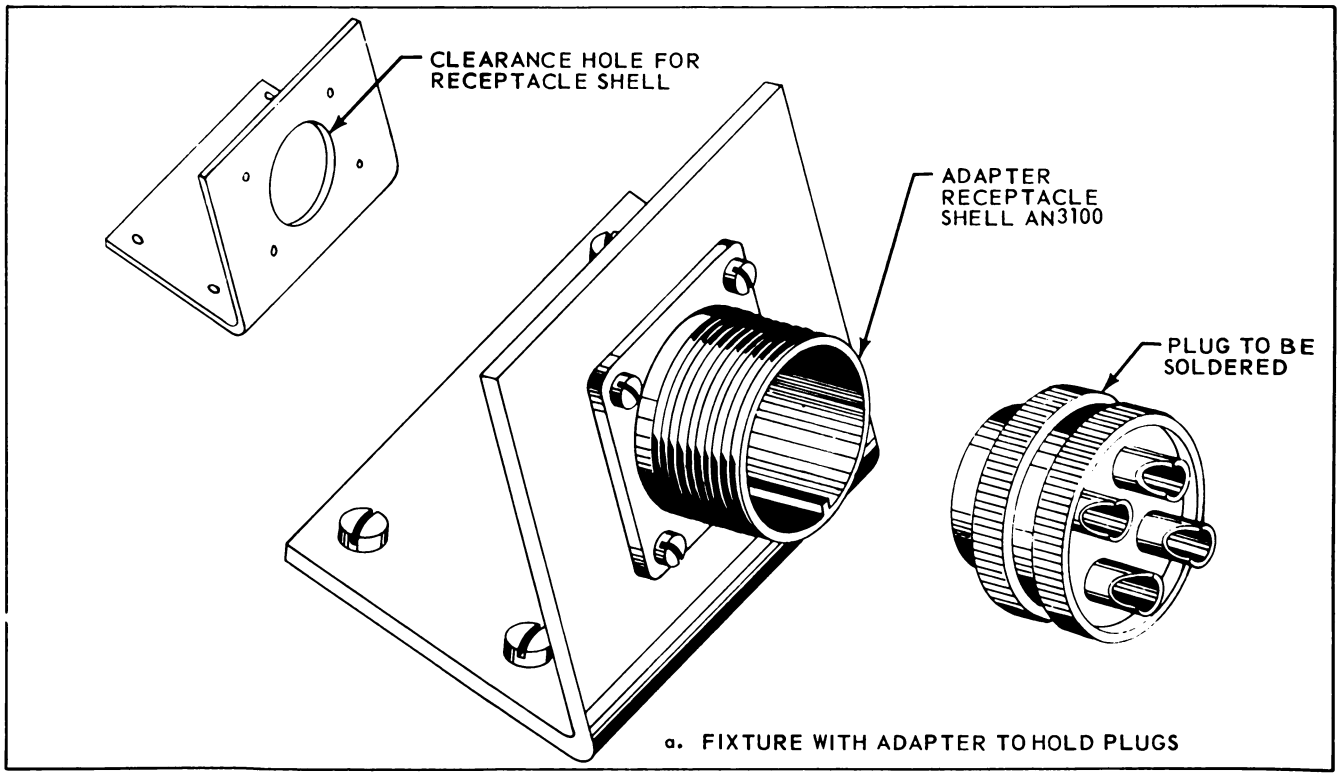
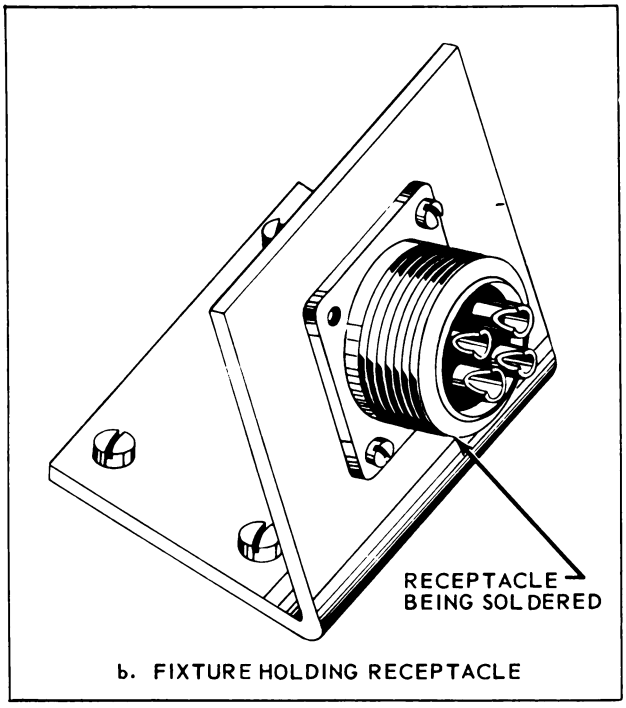


Figure 3–32. Holding Fixtures for Connectors

shown in Figure 3–31. The screen is made from expanded or perforated steel and should be painted to retard corrosion. To solder connectors with a fixed iron, it is necessary to hand hold the connector.



b. FIXTURE HOLDING RECEPTACLE

Figure 3–32. Holding Fixtures for Connectors

If the connector is to be fastened to the bench, a steel bracket bent to a 60° – 75° angle as shown in Figure 3–32 is very useful. To hold a plug use an empty shell from a receptacle having the same thread size. To hold a receptacle use two screws to mount the receptacle with the threaded portion inserted through the hole in the bracket. This will place the solder cups in position for easy soldering.

3–38. SOLDERING SEQUENCE. A good mechanic follows a rigid sequence in soldering wires to a connector. This helps him avoid errors in wiring and also prevents burning or scorching the insulation of wires already soldered. Two useful sequences are shown in Figure 3–33.

a. The soldering of the connector in Figure 3–33a is started at the right or left lower edge, depending on whether the mechanic is left or right handed, and follows the bottom row across. The row above is next and is done in the same direction as the bottom row. This will permit the insert to cool between soldering operations. The operation is repeated for each row in sequence until the connector is completely soldered.

b. The sequence for the connector shown in Figure 3–33b also starts with the bottom row from the right or left. The next step is to solder to the center contacts working out to each edge. The final operation is to solder wires to the top row.

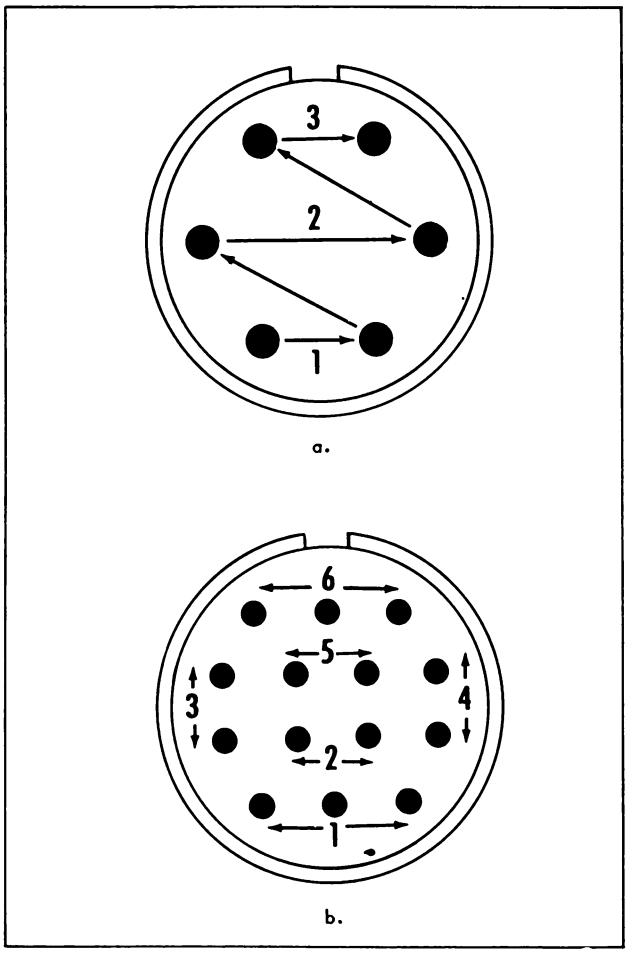


Figure 3–33. Connector Soldering Sequence

The above two sequences are suggested procedures that work well in many aircraft plants. They are not mandatory but it is important for the mechanic to develop a fixed sequence and then not to deviate from that sequence.

3–39. CLEANING SOLDERED CONNECTIONS. After all connections have been made, examine the connector for excess solder, cold joints and flux residues. Take following corrective measures if any of the above are found:

a. Excess solder is removed by using a soldering iron which was carefully wiped clean with a heavy cloth.

b. Cold joints are disassembled, all old solder is shaken out and the connections remade using new 60/40 rosin-core solder.

c. Flux residues are removed by use of Stoddard's Solvent applied with a bristle brush. Blow the connector dry with compressed air.

3–40. INSULATING SLEEVE POSITIONING. All connectors, except CANNON Class E and those connectors which are to be potted, have insulating sleeves which are installed over the individual wires prior to

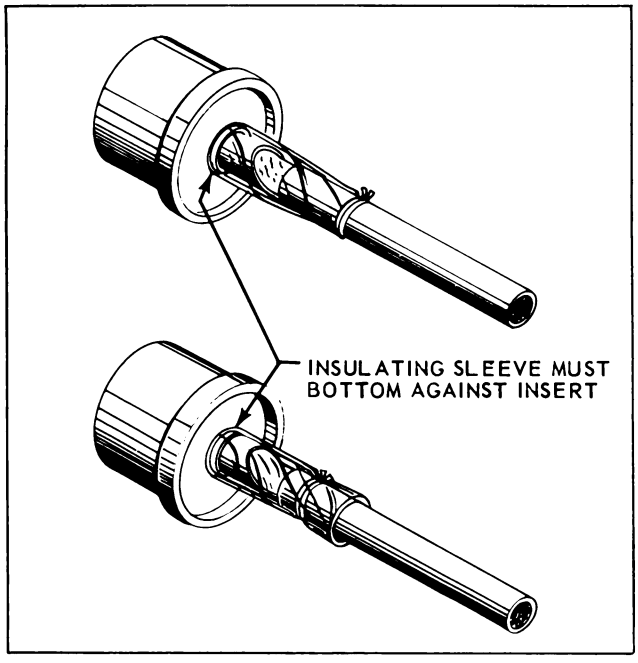


Figure 3–34. Insulating Sleeve Bottomed Against Insert

assembly to solder cups. After the connections are cleaned, push these insulating sleeves down over the contact until they bottom against the insert as shown in Figure 3–34. Tie the insulating sleeves in position to prevent sliding back on the wires. Tie nylon sleeves individually because of nylon's stiffness. Tie all other approved sleeves in groups or as a complete bundle. Be sure that tie will not interfere with cable clamp adapter (AN-3057). Use nylon braid to tie sleeves in place.

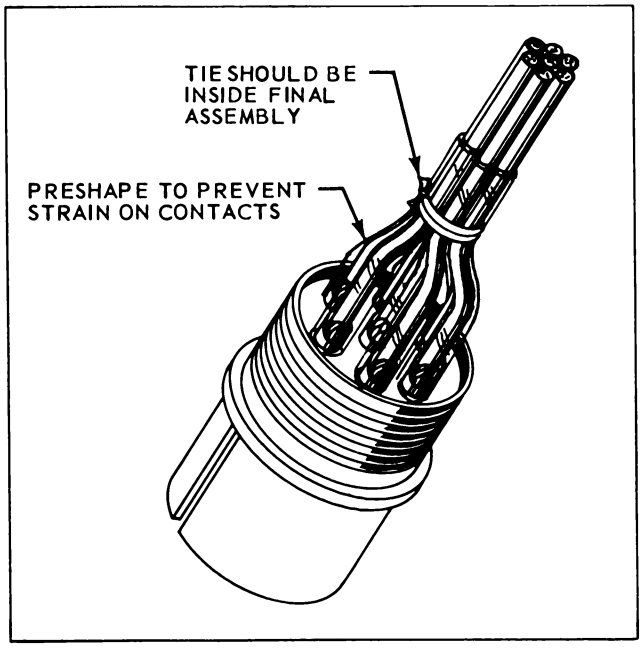


Figure 3–35. Tying Sleeves and Preshaping Wires

3–41. PRESHAPING WIRES. Preshape large diameter wires (#14 and larger) before soldering to contacts. This will avoid strain on soldered connection when AN-3057, cable clamp adapter, is installed. See Figure 3–35.

CAUTION

Preshaping is a necessity for connectors using resilient inserts. Side strain on the contacts will deform the insert material and prevent proper mating of pin and socket contacts.

3–42. INSTALLATION OF AN 3057 SERIES CABLE CLAMP ADAPTERS.

3–43. AN 3057 CABLE CLAMP ADAPTER TYPES. As described in paragraph 3–13, there are three types of AN 3057 cable clamp adapters in use by the armed services.

a. AN 3057 has a single saddle held by two screws. Contains a metal or plastic washer and a flat rubber

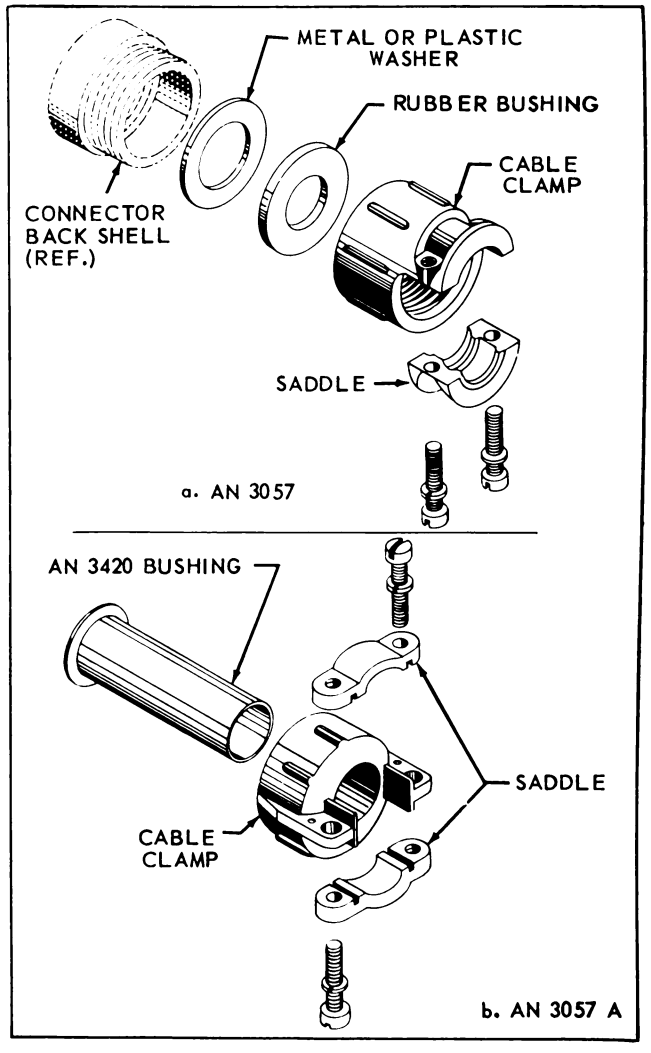


Figure 3–36. AN 3057 Cable Clamp Types – Exploded View

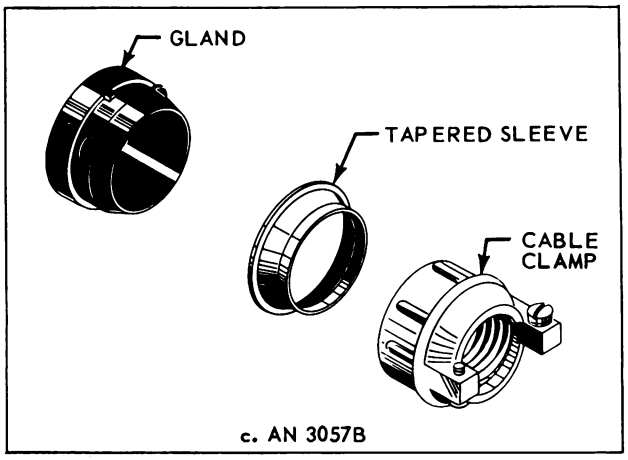


Figure 3–36. AN 3057 Cable Clamp Types – Exploded View

bushing. For shipping, to prevent loss of metal or plastic washer, it is placed inside the clamp and held in place by the rubber bushing. Before using, reverse position, to that shown in Figure 3–36a, so that metal or plastic washer will contact back shell of conductor.

b. AN 3057A has two saddles separated by a centering bar. This cable clamp is supplied with AN 3420 bushing to protect wire bundle under clamp. Add extra bushings if necessary.

c. AN 3057B, the latest version, has a gland and tapered sleeve. The gland is squeezed around the wire bundle when the cable clamp is screwed to the connector back shell.

3–44. INSTALLATION OF AN 3057 CABLE CLAMP.

The AN 3057 cable clamp is installed as follows:

a. Slide AN 3420A telescoping bushings on wire bundle if bundle diameter is too small to be effectively gripped by the saddle.

b. Slide AN 3057 cable clamp without saddle on wire bundle followed by rubber bushing and metal or plastic washer.

c. Assemble wires to connector and tighten back shell. (See other paragraphs for details for each connector class.)

d. Push AN 3057 cable clamp towards back shell and hand tighten. Use strap wrench to tighten fully.

e. Push AN 3420A bushings, if required, into cable clamp until past saddle.

f. Attach saddle with both screws and tighten until 1/16 inch space is left between saddle and body as shown in Figure 3–37. AN 3420A bushing, if used, should bulge slightly when saddle is tight.

NOTE

A wrap of vinyl, nylon or fiber-glass tape can be used instead of AN 3420A bushings. If tape wrap is used, secure with nylon braid behind saddle.

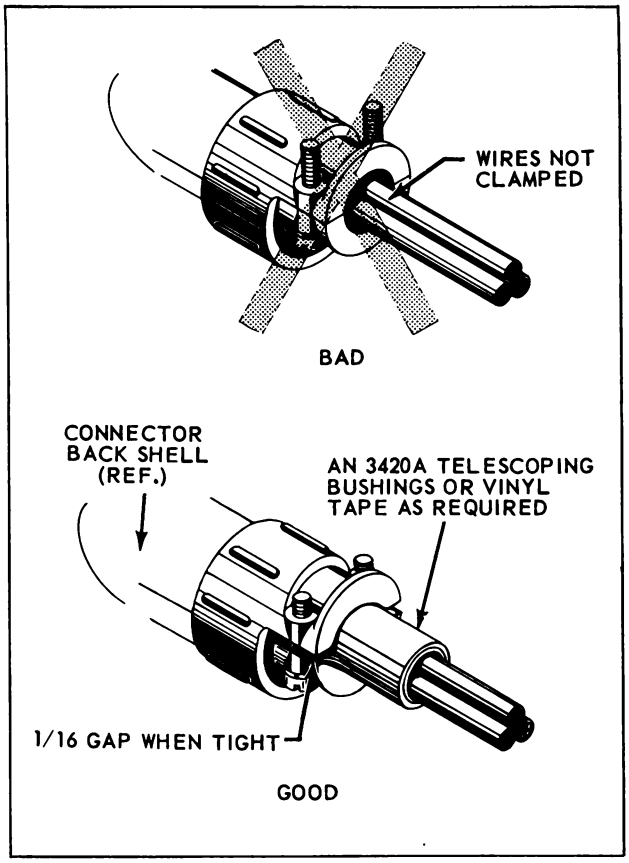


Figure 3–37. Installation of AN 3057 Clamp

3–45. INSTALLATION OF AN 3057A CABLE CLAMP.

The AN 3057A cable clamp is installed as follows:

a. Slide AN 3057A cable clamp without saddles on wire bundle before wires are connected.

b. Slide AN 3420 telescoping bushing on wire bundle before wires are connected.

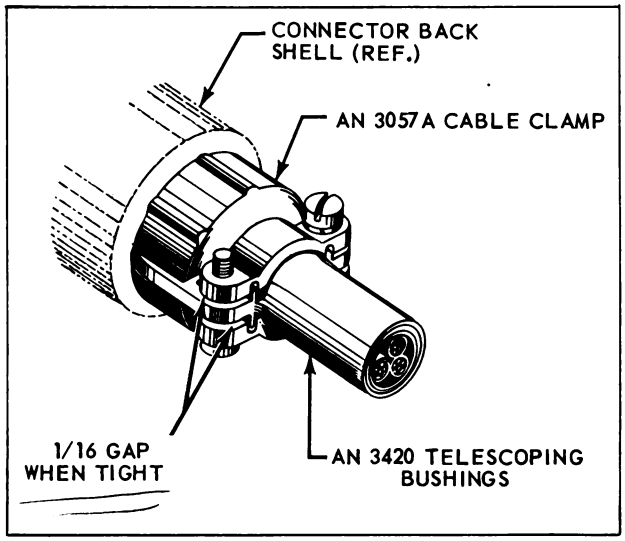


Figure 3–38. Installation of AN 3057A Clamp

c. Assemble wires to connector and tighten back shell (see later paragraphs for details for each connector class).

d. Push AN 3057A cable clamp together with inserted AN 3420 bushing towards back shell and hand tighten. Use strap wrench to tighten fully.

e. Attach both saddles with supplied screws and lockwashers.

CAUTION

When replacing saddles, observe that screw heads are placed so that pushing on screws will tighten cable clamp to back shell.

f. Tighten saddles until 1/16 inch remains between each saddle and the centering bar as shown. Use extra AN 3420 telescoping bushings in original assembly if saddles are not tight with this 1/16 inch opening. See Table XVII for telescoping dimensions.

3-46. INSTALLATION OF AN3057B CABLE CLAMP.

The AN 3057B cable clamp is installed as follows:

a. Slide AN 3420A telescoping bushings, if required, on wire bundle before wires are connected. See Table XVII for telescoping dimensions.

b. Slide AN 3057B cable clamp assembly on wire bundle before wires are connected.

CAUTION

Proper lubrication of gland and tapered sleeve is important for this assembly. In handling parts, keep them clean and free of dirt. Wash away dirt with clean Stoddard's Solvent and relubricate with petrolatum (Federal Specification VV-P-236) as shown in Figure 3–40. Do not apply petrolatum to inside of gland or to serrated face of gland.

c. Assemble wires to connector and tighten back shell (see other paragraphs for details for each connector class).

d. Push AN 3420A bushing, if used, through gland of AN 3057B so that end of bushing is flush with serrated face of gland.

e. Slide entire assembly towards back shell and hand tighten. Use strap wrench to fully tighten until AN 3057B bottoms onto back shell. While tightening, hold wire bundle and telescoping sleeves until gland seats on back shell

NOTE

Shield braid must end outside of AN 3057B cable clamp to retain moisture resistant qualities of clamp. Ground braid to either grounding screw on cable clamp.

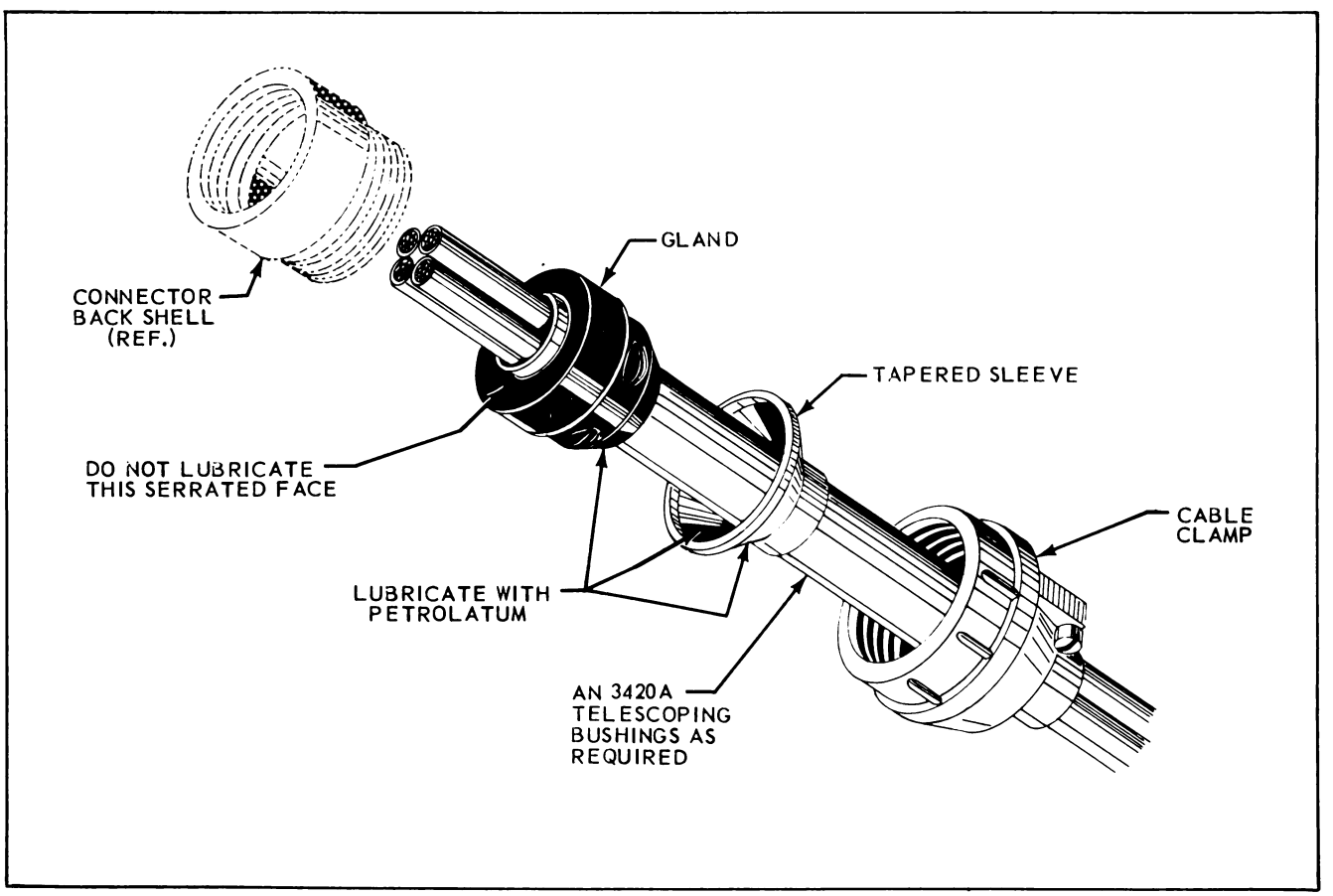


Figure 3–39. Installation of AN 3057B Clamp

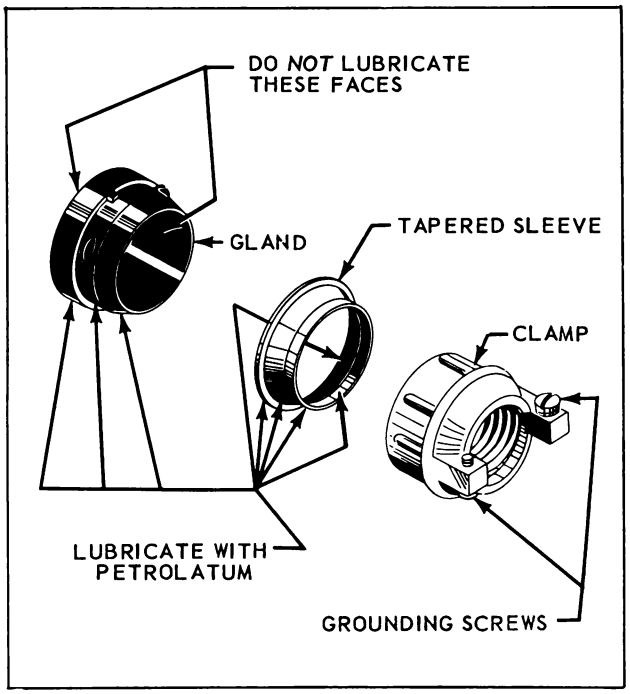


Figure 3–40. Lubrication of AN3057B Cable Clamp

3–47. DISASSEMBLY AND REASSEMBLY OF CONNECTORS.

3–48. AMPHENOL AN CLASS A CONNECTORS. Amphenol Class A connectors are installed as follows: (See Figure 3–41)

NOTE

This procedure is same as Cannon Class A (See para. 3–59).

a. Remove back shell by unscrewing from body assembly. If the back shell is too tight to be loosened by hand, attach connector to mating connector shell held in fixture as illustrated in Figure 3–32; and use strap wrench to loosen back shell. Do not remove coupling nut from body.

CAUTION

Never use pliers to disassemble or reassemble connectors.

b. If all contacts are size 12 or smaller, no further disassembly is required. For larger contacts see paragraph 3–19b.

c. Install the following items on wire bundle in listed order:

1. Cable clamp without saddle.
2. Rubber bushing
3. Metal or plastic washer
4. Back shell
5. Insert retaining ring, if removed in step b.

d. Slide insulating sleeves over each wire in bundle. Sleeves should be placed one inch back from wire ends to avoid burning during soldering operation. See paragraph 3–31 for data about insulating sleeves.

NOTE

Steps e through h apply only if large contacts wire removed in step b.

e. Solder wires to large contacts removed in step b. See paragraphs 3–34 through 3–36 for soldering instructions.

f. Reinstall large contacts by threading through rear insert and inserting contacts into front insert.

g. Reassemble inserts and contacts into body assembly. Be careful to align keyway with key. Do not force the assembly because a damaged keyway will ruin a connector.

h. Replace retaining ring so that end of ring is about 1/4 inch from removal slot as shown in Figure 3–42. This will simplify future disassembly.

Figure 3–42

i. Solder wires to remaining contacts using methods described in paragraphs 3–36b through 3–38.

j. Clean soldered connections and slide insulating sleeves over contacts until they bottom against insert.

k. Tie sleeves to wires using nylon braid as shown in Figure 3–35.

TABLE XVII

Telescoping Bushings

Connector Size	**GROUP I Bushing No.*	**GROUP II Bushing No.*	**GROUP III Bushing No.*	*Inside Diameter in inches* FREE	CLOSED
10	AN3420-3A	AN3420-3A	AN3420-3A	.125	.000
12	-4A	-4A	-4A	.219	.010
14	-6A	-6A	-6A	.312	.114
16	-8A	-8A	----	.438	.222
18	----	----	-10A	.438	.200
20	-12A	-12A	----	.541	.270
24	-16A	-16A	----	.750	.433
30	----	-18A	----	.938	.504
32	-20A	----	----	.938	.620
36	----	-24A	----	1.125	.682
40	-28A	----	----	1.125	.816

*Bushings listed in each group will telescope respectively when free.

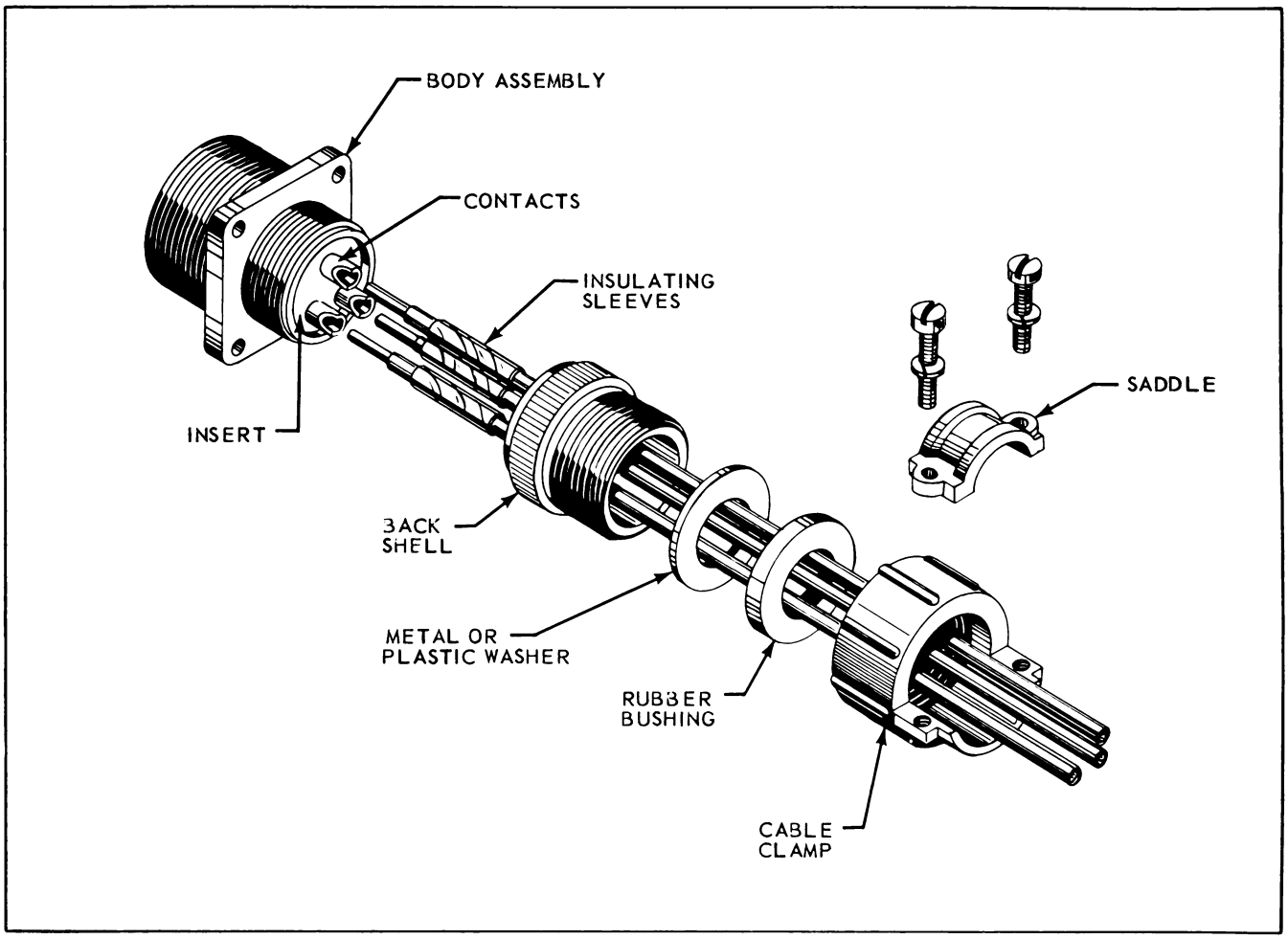


Figure 3–41. Installation of Amphenol Class A Connector

1. Slide back shell down over wire bundle and hand tighten to body assembly. Use strap wrench to tighten back shell 1/8 turn beyond hand tight.

m. Install cable clamp as described in paragraph 3–44.

3–49. AMPHENOL AN CLASS B CONNECTORS. Amphenol Class B connectors are installed as follows:

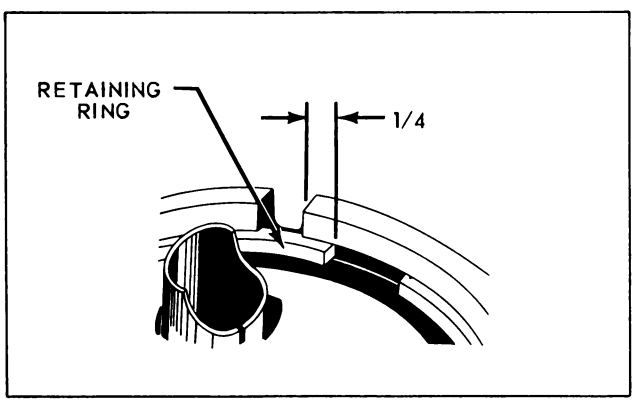


Figure 3–42. Location of End of Retaining Ring

a. Remove back shell by loosening captive assembly screws. Do not remove coupling nut from body.

b. If all contacts are size 12 or smaller, no further disassembly is required. For larger contacts see paragraphs3–19b.

c. Install the following items on wire bundle in listed order:

1. Cable clamp without saddle
2. Rubber bushing
3. Metal or plastic washer
4. Back shell
5. Insert retaining ring, if removed in step b.

d. Slide insulating sleeves over each wire in bundle. Sleeves should be placed one inch back from wire ends to avoid burning during soldering operation. See paragraph 3–31 for data about insulating sleeves.

NOTE

Steps e through h apply only if large contacts were removed in step b.

e. Solder wires to large contacts removed in step b. See paragraphs 3–34 through 3–36 for soldering instructions.

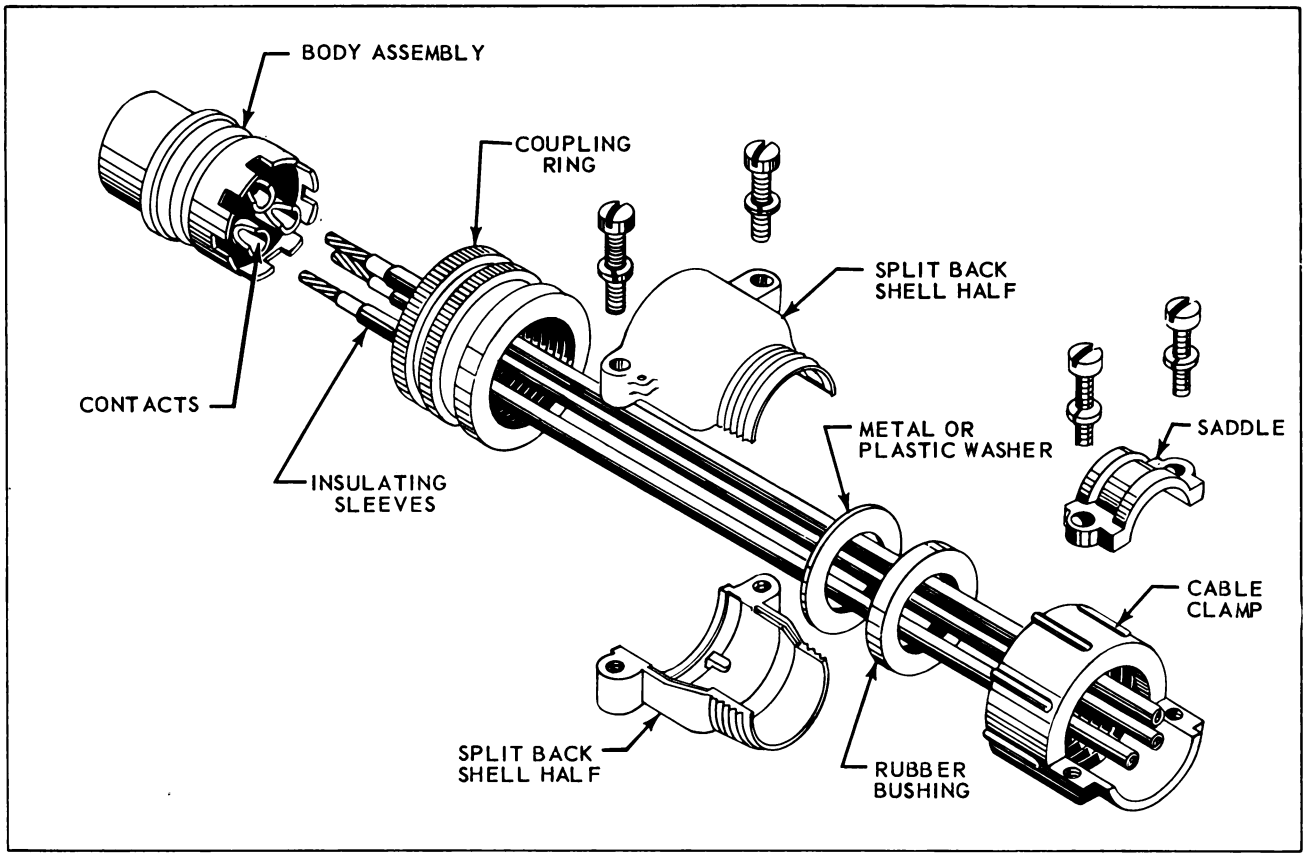


Figure 3–43. Installation of Amphenol Class B Connector

f. Reinstall large contacts by threading through rear insert and inserting contacts into front insert.

g. Reassemble inserts and contacts into body assembly. Be careful to align keyway with key. Do not force the assembly because a damaged keyway will ruin a connector.

h. Replace retaining ring so that end of ring is about 1/4 inch from removal slot as shown in Figure 3–42. This will simplify future disassembly.

i. Solder wires to remaining contacts using methods described in paragraphs 3–36b through 3–38.

j. Clean connections and slide insulating sleeves over contacts until they bottom against insert.

k. Tie sleeves to wires using nylon braid as shown in Figure 3–35.

l. Reassemble split shell. Be careful not to pinch wires.

NOTE

Angle back shells can be assembled at 45° angles. See engineering drawing for proper setting for each installation.

m. Install cable clamp as described in paragraph 3–44.

n. Safety wire the split back shell holding screws, if required by engineering, by passing the wire through the screw heads (see Figure 3–44), crossing it and completing with a twist.

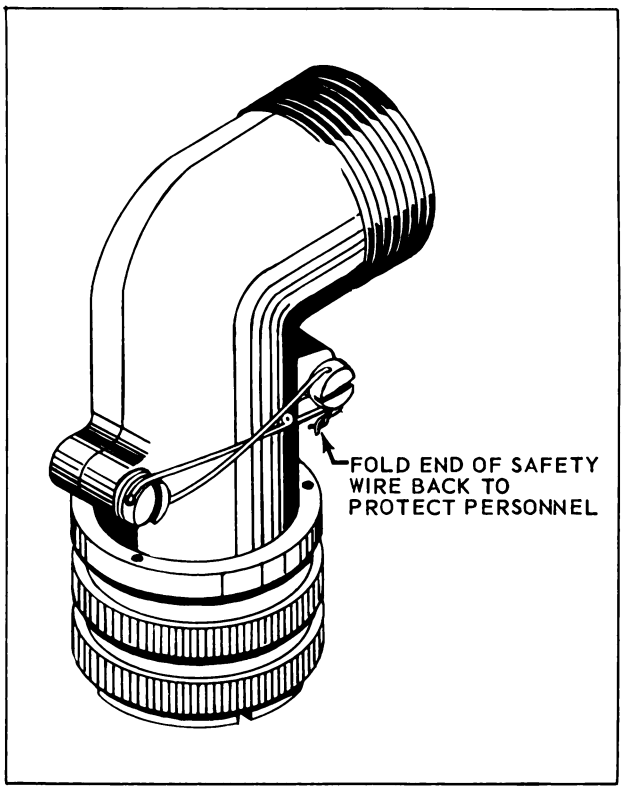


Figure 3–44. Safety Wiring Class B Connector

3–50. AMPHENOL AN CLASS C CONNECTORS. Amphenol Class C connectors are installed as follows:

a. Remove back shell by unscrewing from body. If the back shell is too tight to be loosened by hand, attach connector to mating connector shell held in fixture as illustrated in Figure 3–32; and use strap wrench to loosen back shell. Do not remove coupling nut from plug body.

CAUTION

Never use pliers to disassemble or reassemble connectors.

b. Large contacts (8, 4 and 0) are threaded into insert. Unscrew the contact for soldering. Do not twist or attempt to remove small contacts.

CAUTION

Do not remove Class C inserts. These connectors are pressurized and insert removal will break the pressure seals.

c. Install the following items on wire bundle in listed order.

1. Cable clamp without saddle
2. Rubber bushing
3. Metal or plastic washer
4. Back shell

d. Slide insulating sleeves over each wire in bundle. Sleeves should be placed one inch back from wire ends to avoid burning during soldering operation. See paragraph 3–31 for data about insulating sleeves.

f. Reinstall large contacts. Tighten contact until it is seated firmly against lead pressure washer. Use curved long nose pliers if necessary.

g. Solder wires to remaining contacts using methods described in paragraphs 3–36b through 3–38.

h. Clean connections and slide insulating sleeves over contacts until they butt against the insert.

i. Tie sleeves to wires using nylon braid as shown in Figure 3–35.

j. Slide back shell down over wire bundle and hand tighten to body assembly. Use strap wrench to tighten back shell 1/8 turn beyond hand tight.

k. Install cable clamp as described in paragraph 3–44.

3–51. AMPHENOL FIREPROOF CONNECTORS. Amphenol fireproof connectors have crimp type contacts to withstand high temperature operating requirements. Installation is as follows:

a. Use spanner wrench to remove spanner nut. See Figure 3–46.

b. Tap body assembly lightly in palm of hand to remove and separate contact and insert assembly.

c. Install the following items on wire bundle in listed order:

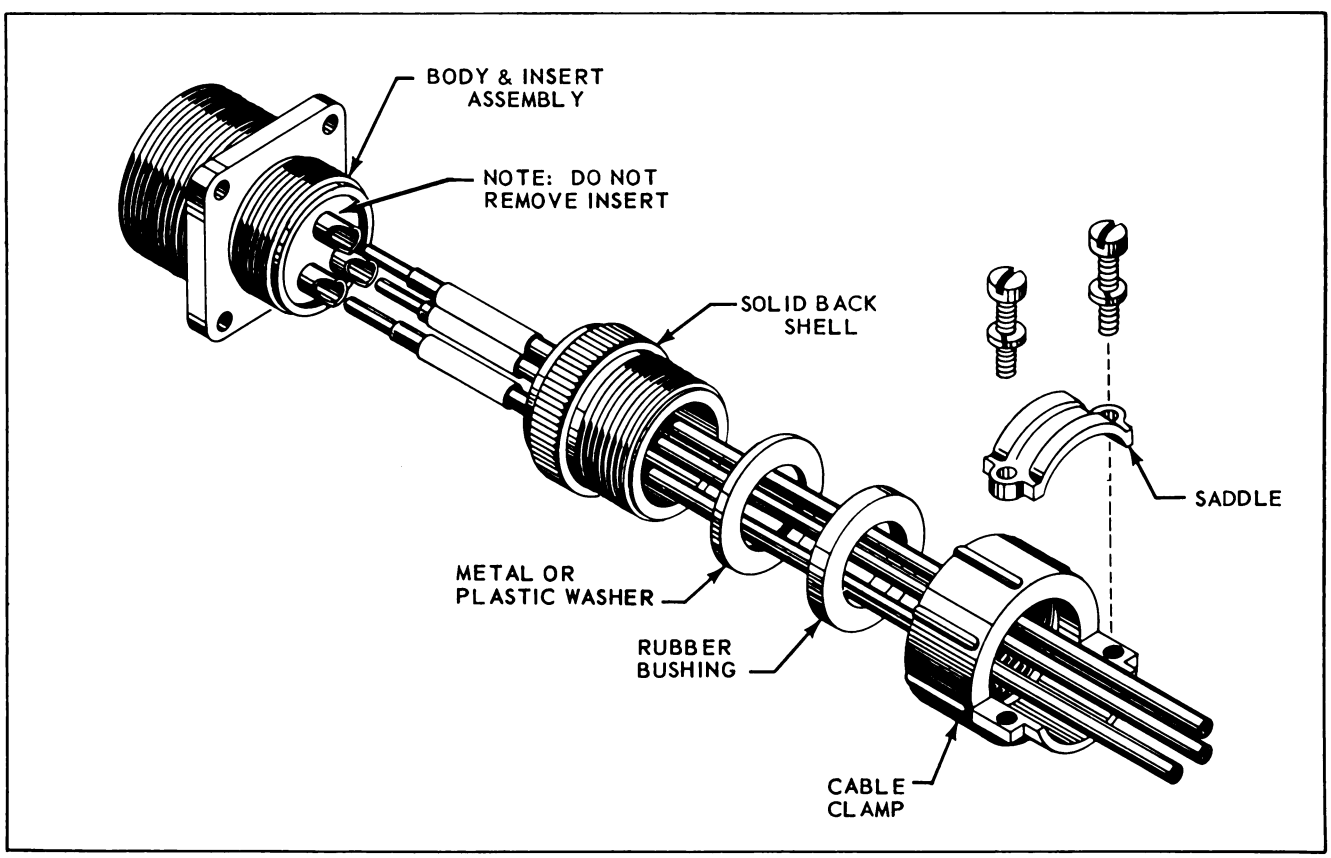


Figure 3–45. Installation of Amphenol Class C Connector

1. Conduit with coupling nut or other required fittings.

NOTE

Fitting threads are not identical with standard "AN" connectors of same size. Use fitting sizes listed in Table XVIII.

2. Spanner nut
3. Ceramic rear insert
4. Silicone rubber gasket

d. Crimp wires into contacts using any of the methods described in Section V.

e. Reassemble by (1) sliding contacts into ceramic front insert; (2) pushing silicone rubber gasket down over contacts; and (3) sliding ceramic rear insert over contacts.

f. Examine contact and insert assembly to see that parts butt and then slide assembly into body. Tighten spanner nut into place until flush with rear of body shell.

g. Tighten conduit coupling nut or other required fitting over body assembly. Use strap wrench to tighten 1/8 turn beyond hand tight.

TABLE XVIII
Amphenol Fireproof Connectors and Fittings

Connector Size	*Fitting Size*	*Fitting Thread*
18	12	1-3/16 – 18
22	16	1-7/16 – 18
32	24	2 – 18
36	28	2-1/4 – 16

3-52. AMPHENOL POTTING CONNECTORS. Amphenol potting connectors are supplied with a plastic potting mold or with a reusable split type metallic mold. Installation is as follows:

a. Slide a plastic mold over the wire bundle if this type of mold is to be used. The split reusable mold is not placed on the wire bundle beforehand.

b. Solder wires to contacts. See paragraphs 3-34 through 3-38 for soldering instructions.

CAUTION

Do not install insulating sleeves over individual wires. Potting compound will not cure properly in contact with vinyl sleeving.

c. Install spare wires on all unused pins. Use largest AN gage wire that would normally be attached to each contact. Spare wires are approximately 9 inches long. (See Figure 3-47.)

d. Clean the complete connector assembly by scraping off rosin and then brush vigorously in new unused, Stoddard's Solvent followed by second rinse in clean Stoddard's Solvent. See Figure 3-48.

CAUTION

Do not breathe methylene chloride fumes. Use only in well ventilated area.

e. Rinse area to be potted with methylene chloride applied from hand operated laboratory wash bottle or similar device.

NOTE

Complete potting within two hours after cleaning.

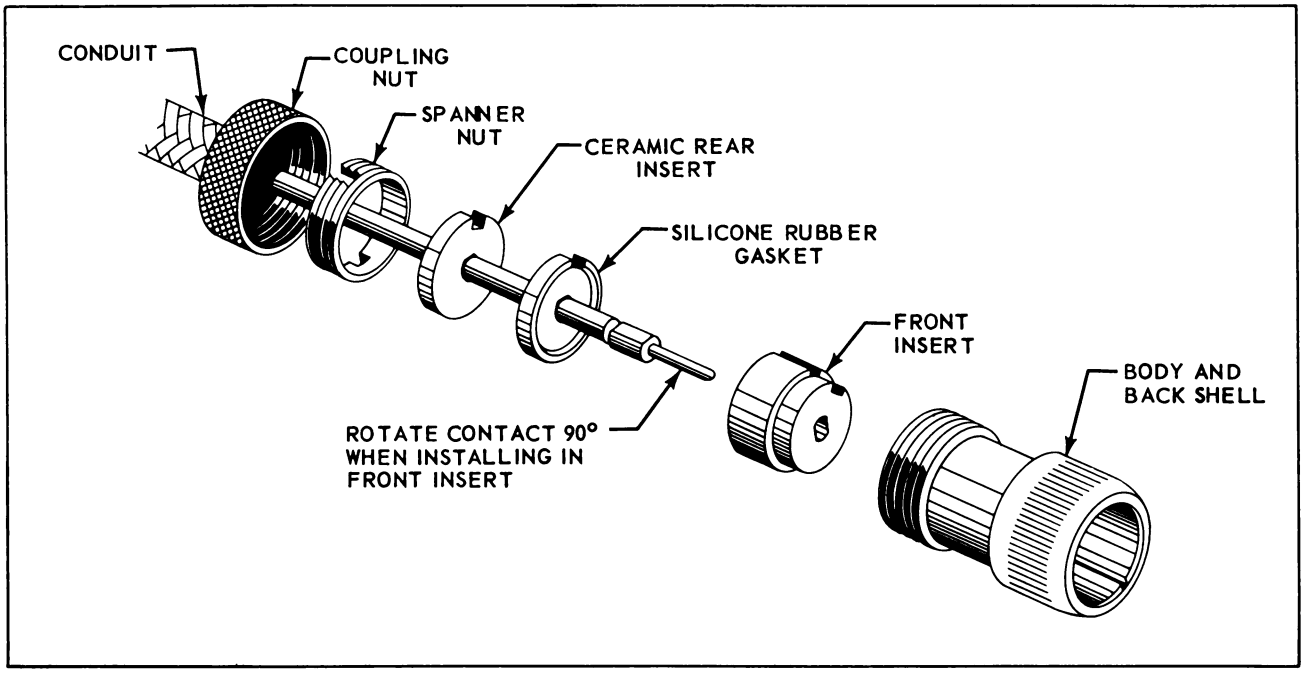


Figure 3-46. Installation of Amphenol Fireproof Connector

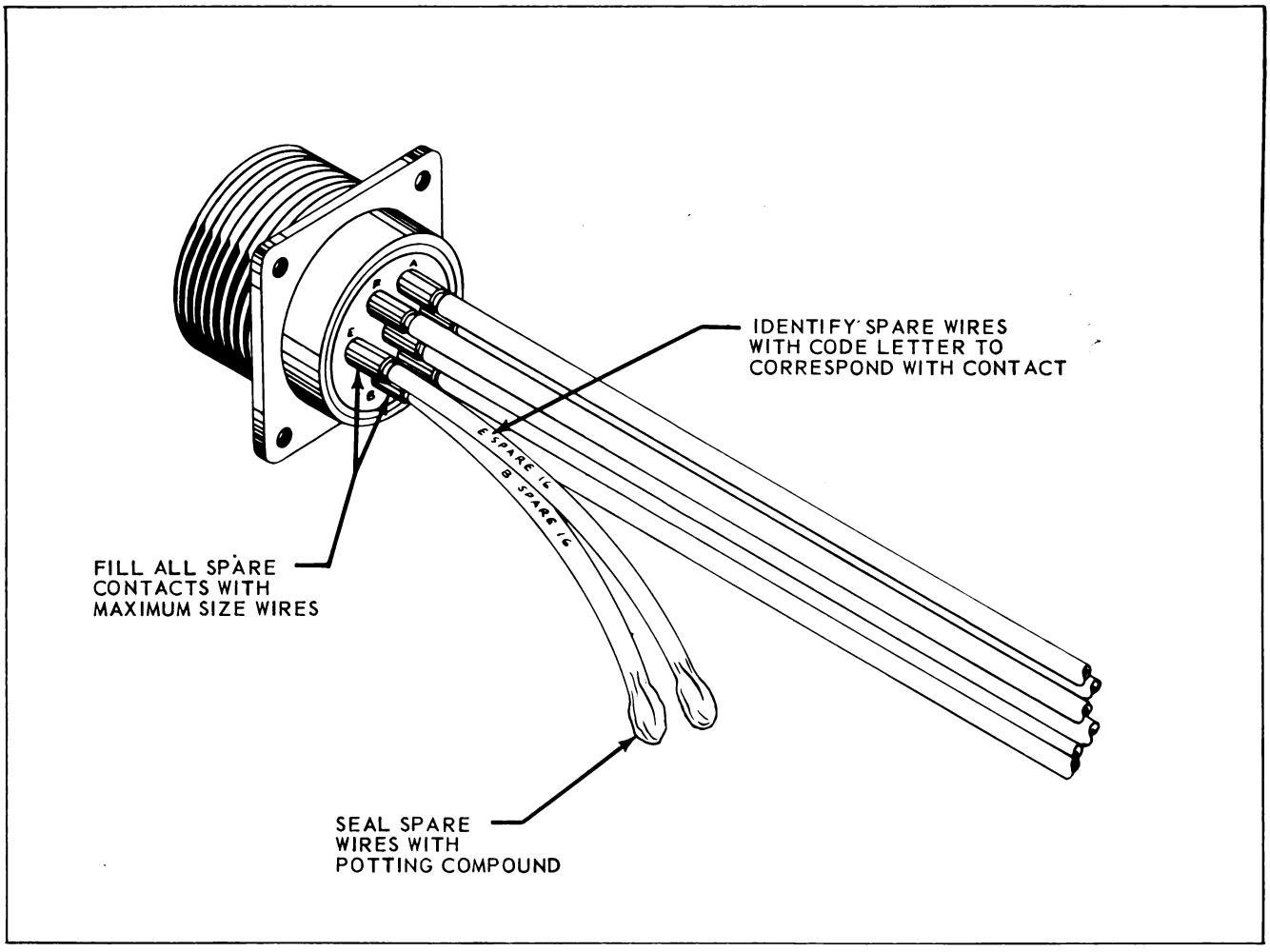


Figure 3-47. Spare Wires for Potting Connector

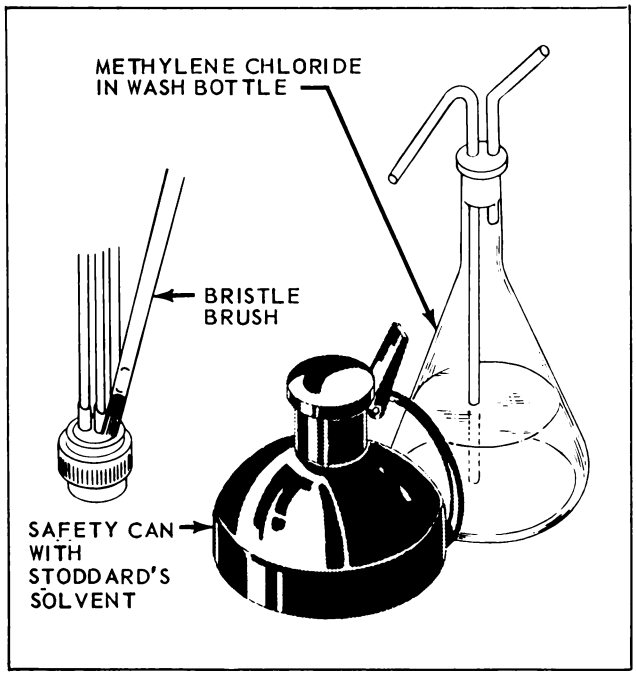


Figure 3-48. Cleaning Connector Prior To Potting

f. Install the reusable mold or slide plastic mold into position.

g. Insert potting compound prepared in accordance with paragraph 3-67. Fill back of connector by inserting nozzle down between wires until it almost touches back of insert (See Figure 3-49). Fill slowly while moving nozzle back from insert and watch compound to be sure no air bubbles are trapped. Fill to top of mold. Tamp down the compound, if necessary, with a wooden or metal 1/8 inch dowel. Tap connector assembly on a resilient surface or vibrate mechanically to help flow the compound into all spaces and to release trapped air.

h. Seal the ends of all spare wires by dipping into potting compound to a depth of about 1/2 inch. (See Figure 3-47).

i. Immediately after filling each connector, tie the wires together loosely about 6 inches back from connector. Be sure that wires are centrally located in the connector so that each wire is completely surrounded by potting compound. Suspend the assembly by placing the tie over a nail as shown in Figure 3-49 and allow to air cure for at least 1-1/2 hours at 75°F without any movement.

WARNING

The accelerator contains a toxic lead compound. Avoid excessive skin contact. Clean hands thoroughly after using. Use gloves.

j. Carefully place assembly still suspended from nail into drying oven for 3 to 4 hours at 100°F. or air cure at 75°F for 24 hours.

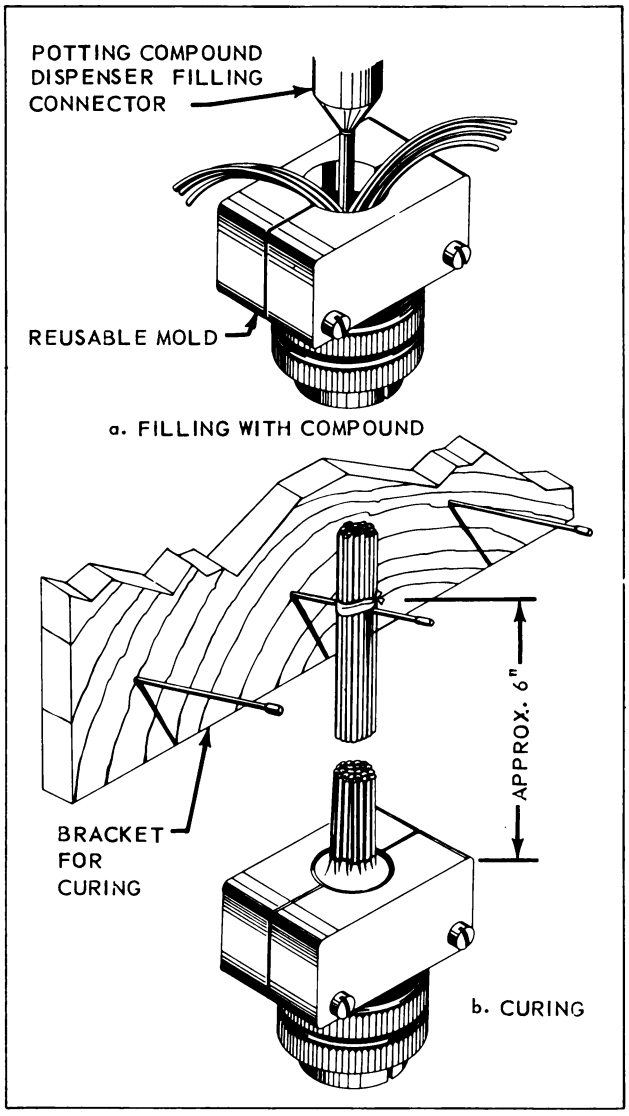


Figure 3–49. Filling and Curing Potting Connector

NOTE

Full cure with maximum electrical characteristics is not achieved until 24 hours after potting. Do not perform any electrical insulation resistance tests until this period has passed.

k. Apply a light film of lubrication oil to all exterior metal surfaces after potting compound is completely cured.

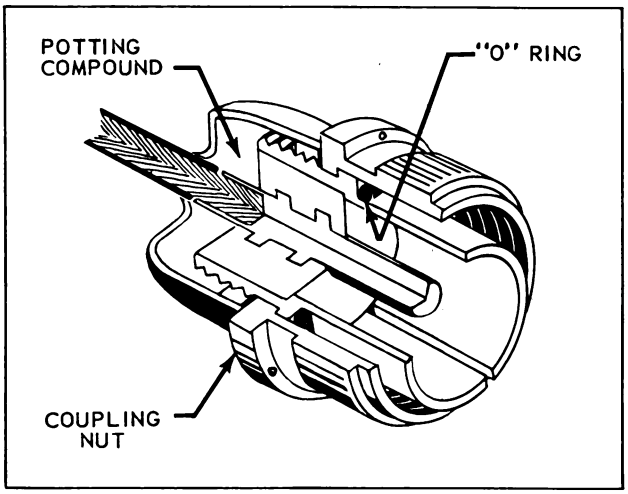


Figure 3–50. Installation of "O" Ring on Potted Connector

l. Moisture seal plugs by installing an O-ring (MS 29513) on the barrel as shown in Figure 3–50. Select O-ring to match barrel diameter from Table XIX.

TABLE XIX
O-Ring Sizes for AN Connectors

Plug Size	*O-Ring Thickness*	*O-Ring I.D.*	*MS 29513 Dash Nos.*
8S	.070 inches	.312 inches	–10
10S & 10SL	.070	.364	–12
12 & 12S	.070	.489	–14
14 & 14S	.070	.489	–14
16 & 16S	.070	.614	–16
18	.070	.739	–18
20	.070	.864	–20
22	.070	.989	–22
24	.070	1.114	–24
28	.070	1.364	–28
32	.070	1.364	–28
36	.103	1.737	–132
40	.103	1.987	–136
44	.103	2.237	–140
48	.103	2.487	–144

Roll O-ring tightly against shoulder of plug inside coupling ring. Plug barrel and O-ring must be clean and dry before assembly.

CAUTION

Do not use 2 rings. The added thickness of a second ring will prevent proper mating of contacts.

NOTE

This procedure is also to be followed when potting Bendix or Cannon connections. See paragraphs 3–58 and 3–64.

3–53. BENDIX-SCINTILLA AN CLASS A CONNECTORS. Bendix Class A connectors are installed as follows:

a. Remove back shell by unscrewing from body. If the back shell is too tight to be loosened by hand, attach the connector to mating connector shell attached to fixture as illustrated in Figure 3–32; and use a strap wrench to loosen back shell. Do not remove coupling nut from plug body.

CAUTION

Never use pliers to disassemble or reassemble connectors.

b. If all contacts are size 12 or smaller, no further disassembly is required. Larger contacts such as size 8, 4 or 0 are removed by applying pressure on solder well end by means of steel or bakelite rod slightly smaller in diameter than the solder well. See Figure 3–16 for arbor press fixture most suitable for this operation. Table XX lists diameter of rods for removing contacts.

TABLE XX

Contact Removal Tool Diameter

Contact Size	*Rod Diameter (inches)*
0	.450
4	.312
8	.187

CAUTION

Hold the connector so that pressure is applied in a straight line with contacts. Pushing at an angle may damage the contacts. Bent contacts must be replaced. Do not attempt to straighten damaged contacts.

c. Install AN 3057B cable clamp as described in paragraph 3–46.

d. Slide insulating sleeves over each wire in bundle. Sleeves should be placed one inch back from wire ends to avoid burning during soldering operation. See Table XVI for sleeving sizes.

e. Solder wires to larger contacts removed in step b. See paragraphs 3–34 and Figure 3–36 for soldering instructions.

f. Reinstall large contacts by pushing them through rear of insert until seated. Use alcohol as a lubricant, if necessary. Install each contact, when cool, before proceding to solder next contact. This will help avoid errors. Use a bakelite screwdriver to aid in seating contacts. (See Figure 3–52.)

CAUTION

Use care not to fold thin lip of rubber into hole with contact.

g. Solder wires to remaining smaller contacts using one of the methods described in paragraphs 3–36b through 3–38.

h. Slide insulating sleeves over cooled connections until they bottom against insert.

i. Slide back shell down over wire bundle and hand tighten to body. Use strap wrench to tighten back shell until it bottoms.

j. Slide telescoping sleeves, if required, through gland until flush with inside edge. Hold telescoping sleeves in back of cable clamping nut while engaging threads. Do not release telescoping sleeves until gland seats on back shell. See paragraphs 3–46 for details.

k. Tighten cable clamp with strap wrench until it bottoms. Hold connector in fixture while tightening cable clamp.

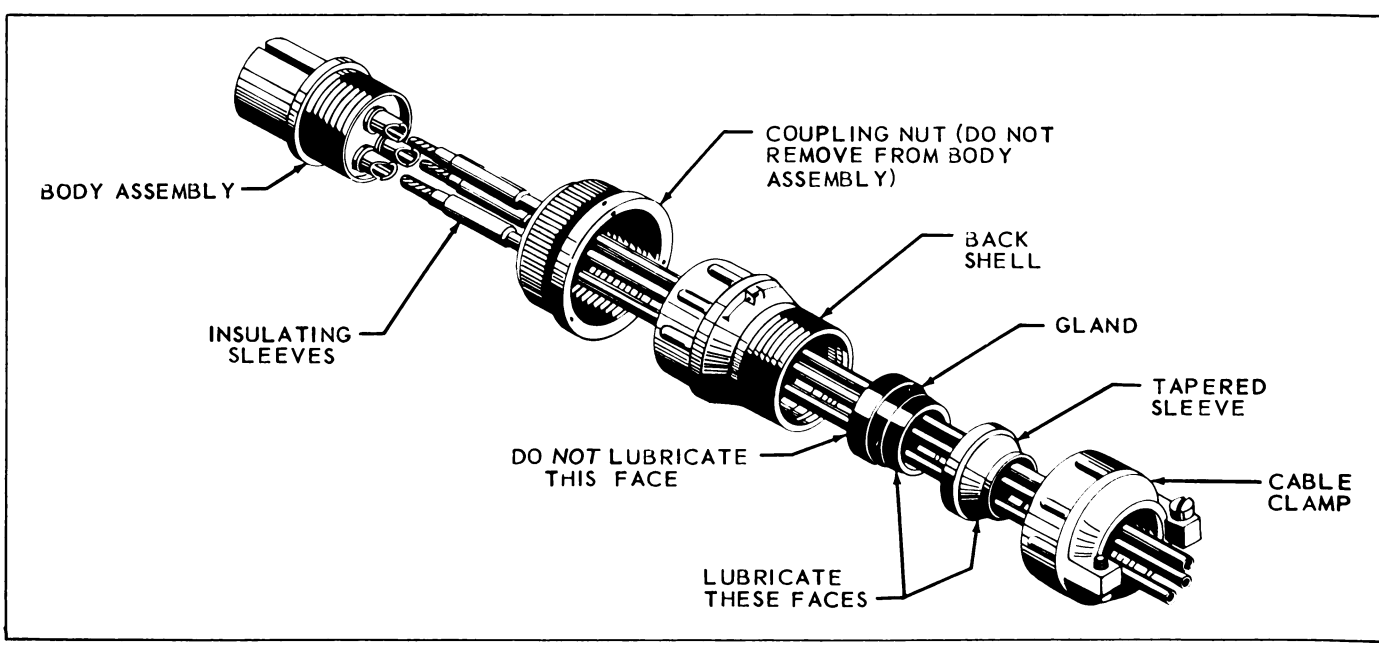


Figure 3–51. Installation of Bendix Class A and C Connectors

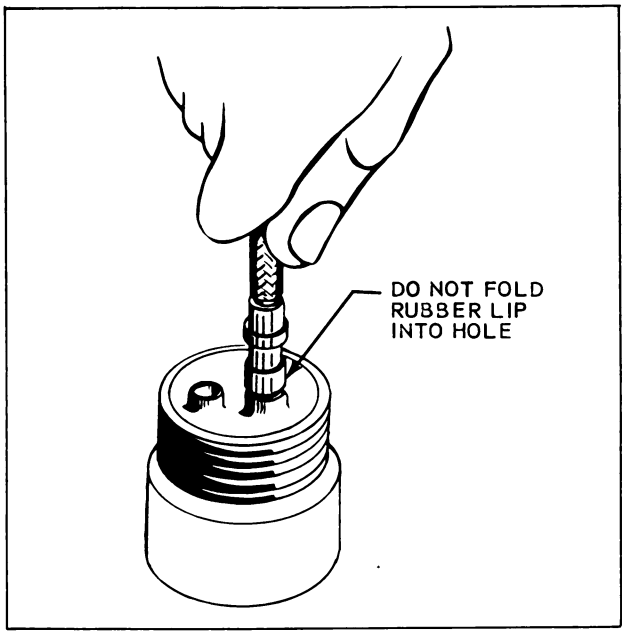


Figure 3–52. Reinstalling Contacts in Resilient Inserts

CAUTION

Keep all parts free of dirt and foreign material. Clean dirty parts with Stoddard's Solvent and relubricate all threads and the indicated parts of gland and tapered sleeve as shown in Figure 3–40 with petrolatum.

3–54. BENDIX-SCINTILLA AN CLASS C CONNECTORS. Bendix Class C connectors are pressurized and care should be taken to avoid breaking the pressure seal. Installation procedure for Bendix Class C connectors is exactly the same as for Bendix Class A connectors.

CAUTION

Never remove insert from Class C connector as this would break the pressure seal incorporated in the unit at the time of factory assembly.

3–55. BENDIX-SCINTILLA AN CLASS E CONNECTORS. Bendix Class E connectors are installed as follows:

a. Remove cable clamp by unscrewing from back shell. Slide cable clamp over wire bundle.

b. Check tapered sleeve and grommet for thin film petrolatum lubricant on indicated surfaces. (See Figure 3–53.)

c. Slide tapered sleeve over wire bundle.

d. Insert pretinned wires through proper holes in grommet.

e. Unscrew back shell from body assembly and slide over wire bundle. Do not remove coupling nut from plug body.

NOTE

Grommet is coded to match insert coding.

Use alcohol as a lubricant if necessary. After wires are threaded through grommet, use air blast to dry alcohol.

f. Install insulating sleeves on wires.

g. Solder wires to contacts as described for Bendix-Scintilla Class A connectors in paragraph 3–53.

h. Slide insulating sleeves over cooled connections until they bottom against insert.

i. Slide back shell down over wire bundle and hand tighten to body shell.

j. Examine insulating sleeves. They should not project over shoulder in back shell.

k. Use strap wrench to tighten back shell until it bottoms.

l. Carefully push grommet down over wire until it is seated in shoulder of back shell.

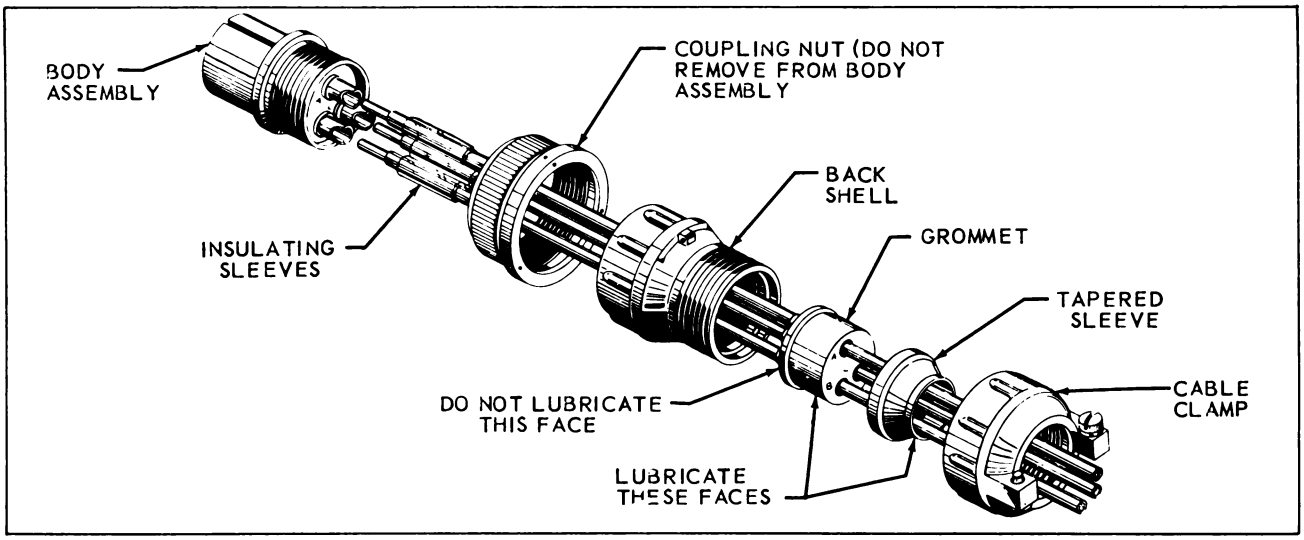


Figure 3–53. Installation of Bendix Class E Connector

CAUTION

Do not allow wires to fold inside back shell.

m. Fill all unused holes with polyethylene rods. The rods are the same diameter as the wires for each hole. Rod length is same as grommet thickness.

n. Slide tapered sleeve and cable clamp over grommet and hand tighten.

o. Tighten cable clamp with strap wrench until it bottoms.

3–56. BENDIX-SCINTILLA FIREPROOF CONNECTORS. Bendix fireproof connectors have crimp-on type contacts to withstand high temperature operating requirements. Installation is as follows:

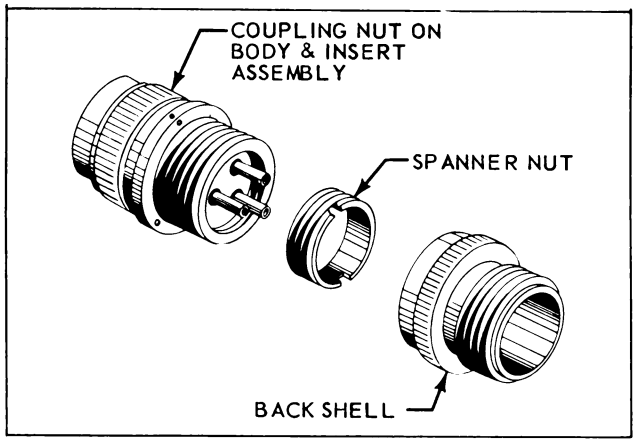


Figure 3–54. Bendix Fireproof Connector – Partial Disassembly

a. Remove back shell by unscrewing from body. Do not remove coupling nut from plug body.

b. Remove spanner nut with fingers.

NOTE

Fireproof connectors are supplied with spanner nut finger tight.

c. Remove insert assembly by grasping and pulling on contact solder wells while pushing on front insert.

d. Remove front insert from contacts.

e. Rotate contacts 90° and push contacts back through sealing insert and rear insert.

NOTE

Use care to prevent tearing or cutting sealing insert.

f. Strip wires to dimensions given in Table XXI.

TABLE XXi

Wire Stripping Dimensions for Bendix-Scintilla Fireproof Connectors

Contact Size	4	8.	12	16
Stripping Dimension (inches)	5/8	5/8	5/16	5/16

NOTE

When using #22 wire in size 16 contacts, strip wire to 5/8 and double back on itself.

TABLE XXII

Crimping Tools and Inspection Data

Contact Size	*Tools*	*AN Wire Size*	*Inspection Test Pull (pounds)*
16	*11-3284-1	22	5 ± 1
		20	10 ± 3
		18	18 ± 3
		16	27 ± 3
12	11-3284-1	14	37 ± 3
		12	37 ± 3
8	**MY29	***10	50 ± 5
		8	50 ± 5
4	MY29	*** 6	75 ± 10
		4	100 ± 10

(*) 11-3284-1 tool is made by Bendix-Scintilla.
(**) MY-29 tool is made by Burndy.
(***) Use wire well adaptor 10-74696-1 (Bendix) to crimp size 10 wire in size 8 contacts. Use wire well adaptor 10-74696-2 (Bendix) to crimp size 6 wire in size 4 contacts.

NOTE

Size 22 wire must be doubled into size 16 contact before crimping. (See Table XXI.)

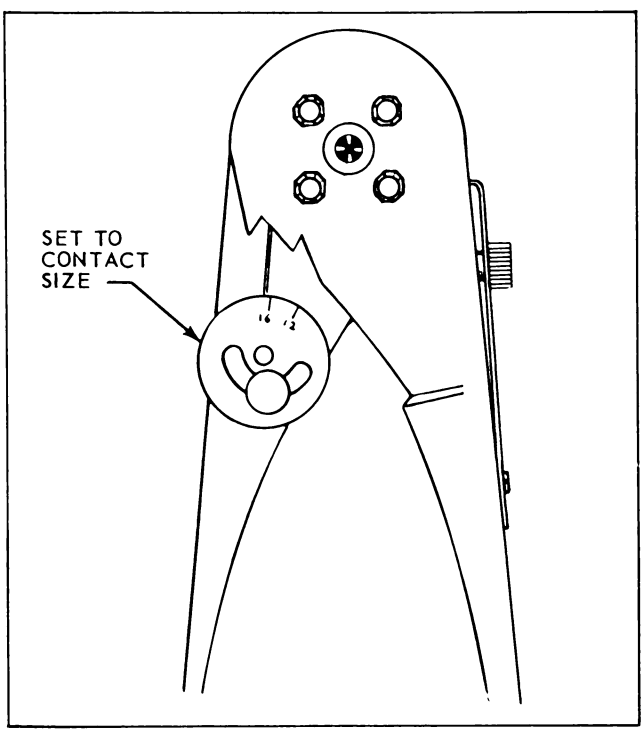


Figure 3–55. Adjustment of Bendix Scintilla 11-3284-1 Crimping Tool for Contact Diameter

NOTE

Use step h. or i. for crimping.

g. Adjust and use crimping tool 11-3284-1 (Bendix) as follows:

1. Set eccentric stop to #16 or #12 to match contact size. See Figure 3–55.

2. Set knurled positioning stop nut to match contact size. See Table XXIII for settings. This positioning will insure locating crimp at 3/32 inch from end of conductor well portion of contact. See Figure 3–56.

TABLE XXIII

Adjustment Settings for Crimping Tool 11-3284-1

Contact Size	*Contact Type*	*Positioning Nut Groove Opposite Scale*
16, 16M	Pins & Sockets	47
16 (long), 16M (long)	Pins	53
16 (long), 16M (long)	Sockets	60
12	Pins & Sockets	60

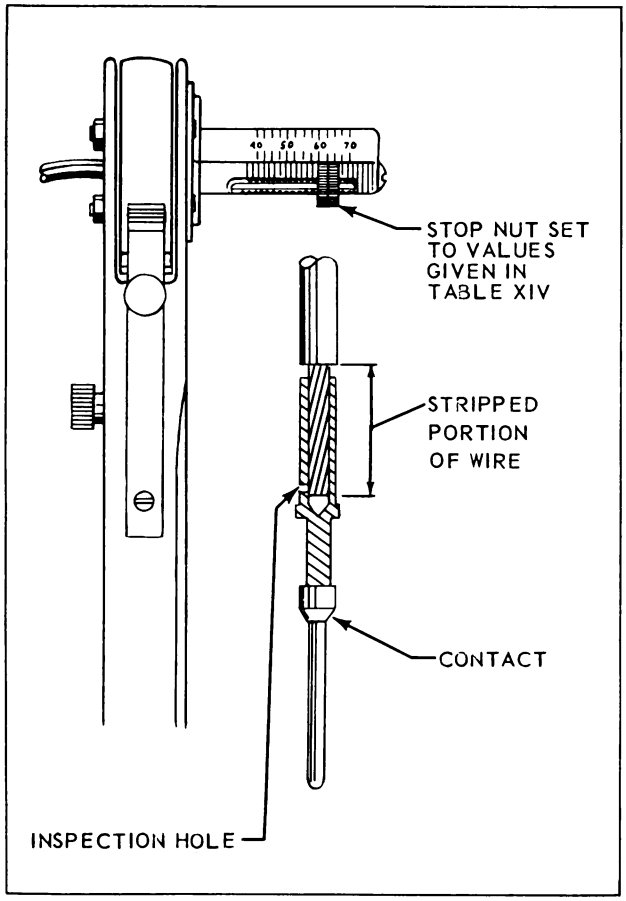


Figure 3–56. Adjustment of Bendix Scintilla 11-3284-1 Crimping Tool for Contact Length

3. Insert stripped wire in contact well. Be sure all strands of wire enter well and that wire is bottomed in well. Check insertion through inspection hole in contact.

4. Slide contact into tool until it is against stop-nut.

5. Hold wire firmly in contact well and close handles completely.

6. Inspect connection by applying test pull listed in Table XXII. Examine crimped area for ruptures.

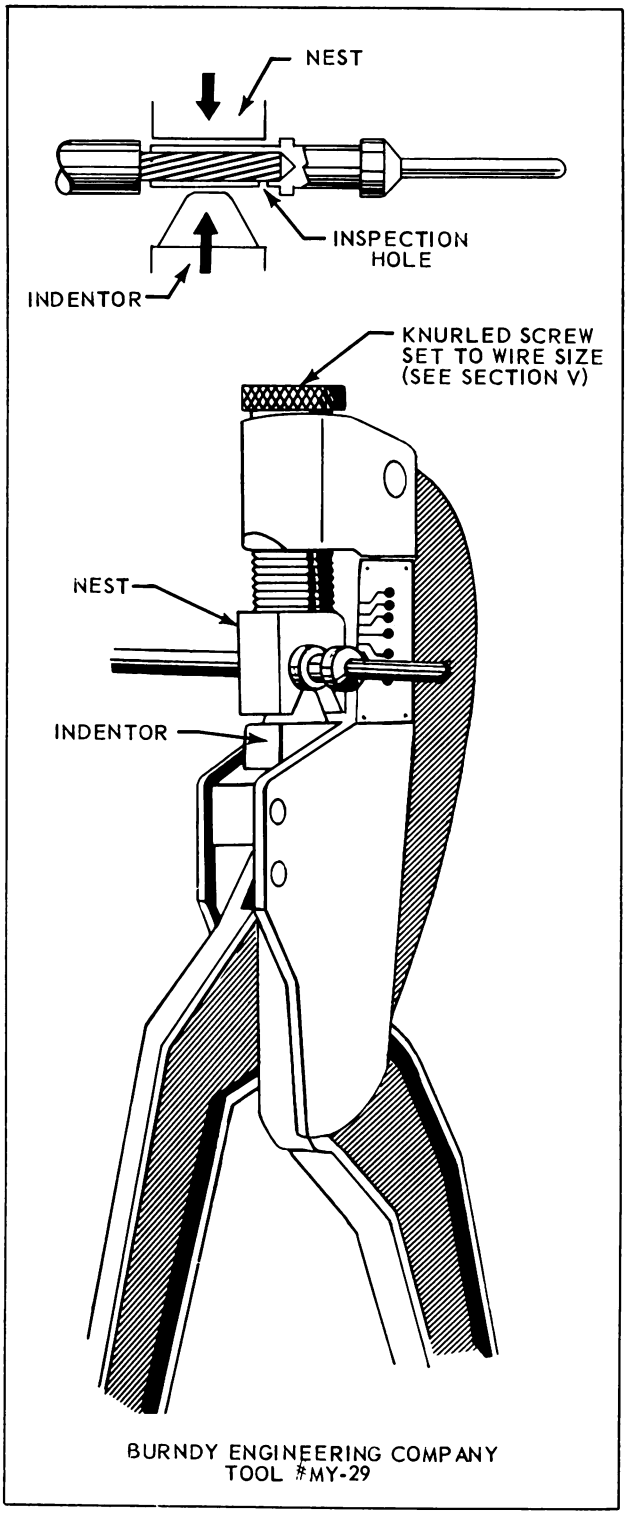


Figure 3–57. Crimping Contact with Burndy MY-29 Tool

i. Adjust and use crimping tool MY29 (Burndy) as follows:

1. Set knurled screw to align index line with No. 8 or No. 4 based on contact size.

2. Insert stripped wire in contact well. Be sure all strands of wire enter well and that wire is bottomed in well. Check insertion through inspection hole in contact.

3. Position first shoulder of contact, from contact well end, against nest (see Figure 3–57). Be sure wire is fully seated in contact well. Close handles completely, release and remove contact.

4. For crimping No. 10 wire to size 8 contact, use wire well adaptor 10-74696-1 (Bendix) with tool set to No. 8 position.

5. For crimping No. 6 wire to size 4 contact, use wire well adaptor 10-74696-2 (Bendix) with tool set to No. 4 position.

6. Inspect connection by applying test pull listed in Table XXII. Examine crimped area for ruptures.

j. Install the following items on wire bundle in listed order:

1 Conduit and adaptor or other fitting as required.
2 Spanner nut.

k. Install contacts with wires attached, through proper holes of rear insert.

NOTE

Smallest outside diameter of rear insert must face wires.

Rotate each contact, after it is installed, 90° to lock it in insert. Push sealing insert over contacts until it butts against front face of rear insert.

CAUTION

Do not tear or cut sealing insert.

l. Align keyway of front insert with keyway of rear insert and slide over contacts down to sealing insert.

NOTE

Largest diameter of front insert must face sealing insert.

m. Align keyway of assembled inserts with keyway inside body. Carefully push assembly into back of body. If sealing insert catches on key, depress insert with dull instrument while it passes under key.

n. Start spanner nut into connector body by hand and tighten with spanner wrench (see Table XXIV), using standard torque wrench handle (1/4 inch drive) as shown in Figure 3–59. Tighten to torque values indicated in Table XXIV.

o. Tighten back shell, or elbow if used, to body. Use strap wrench until back shell is bottomed.

TABLE XXIV

Torque Value Used for Fireproof Connectors

Connector Size	*Spanner Wrench (Bendix)*	*Torque*
10S	11-4045-10	10 lb in.
12S & 12	-12	12
14S & 14	-14	14
16S & 16	-16	16
18	-18	18
20	-20	20
22	-22	22
24	-24	24
28	-28	28
32	-32	32

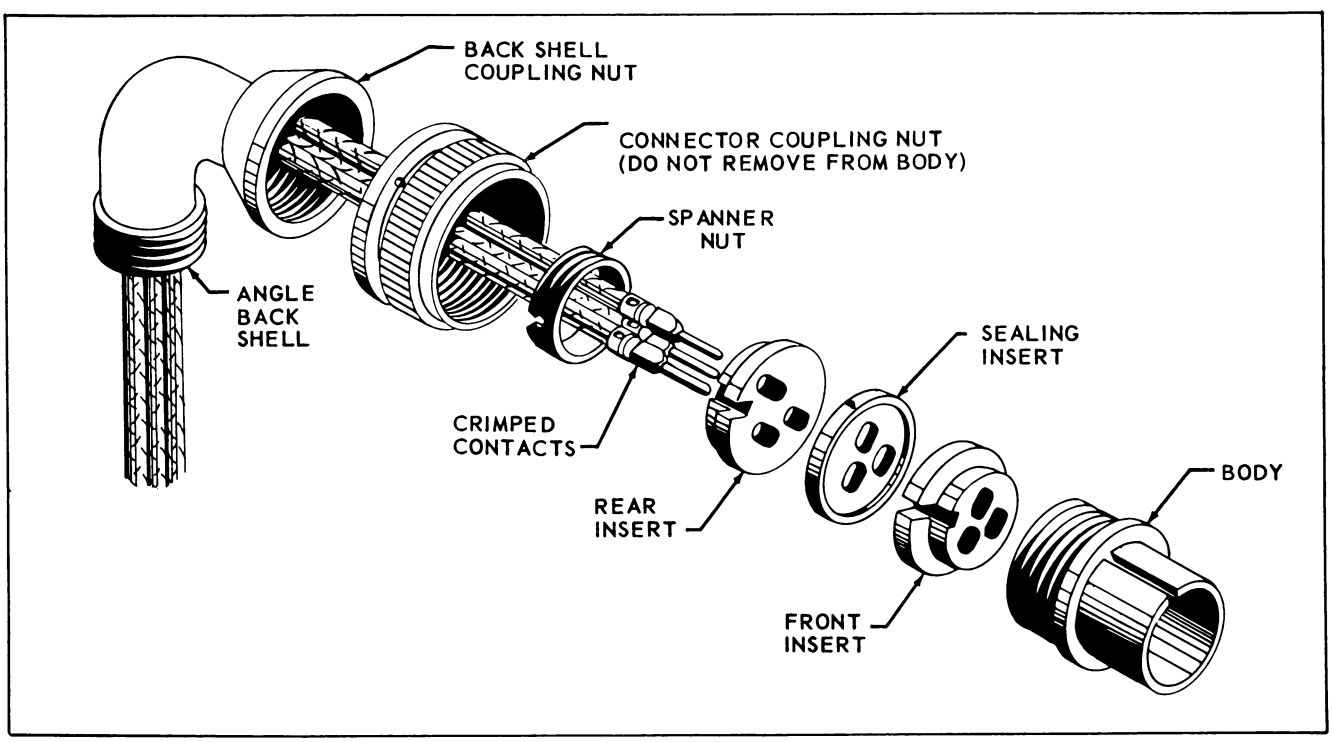


Figure 3–58. Installation of Bendix Fireproof Connector

3–57. BENDIX-SCINTILLA POTTING CONNECTORS. Bendix potting connectors are supplied with a plastic potting mold which is left on the connector after the potting compound has been cured.

3–58. The procedure for Bendix potting connectors is the same as that for Amphenol potting connectors which is described in paragraph 3–52.

3–59. CANNON AN CLASS A CONNECTORS. Cannon Class A connectors are installed in the same manner as Amphenol Class A connectors. See paragraph 3–58. The cable clamp supplied by Cannon is AN3057A. Install this cable clamp as described in paragraph 3-45.

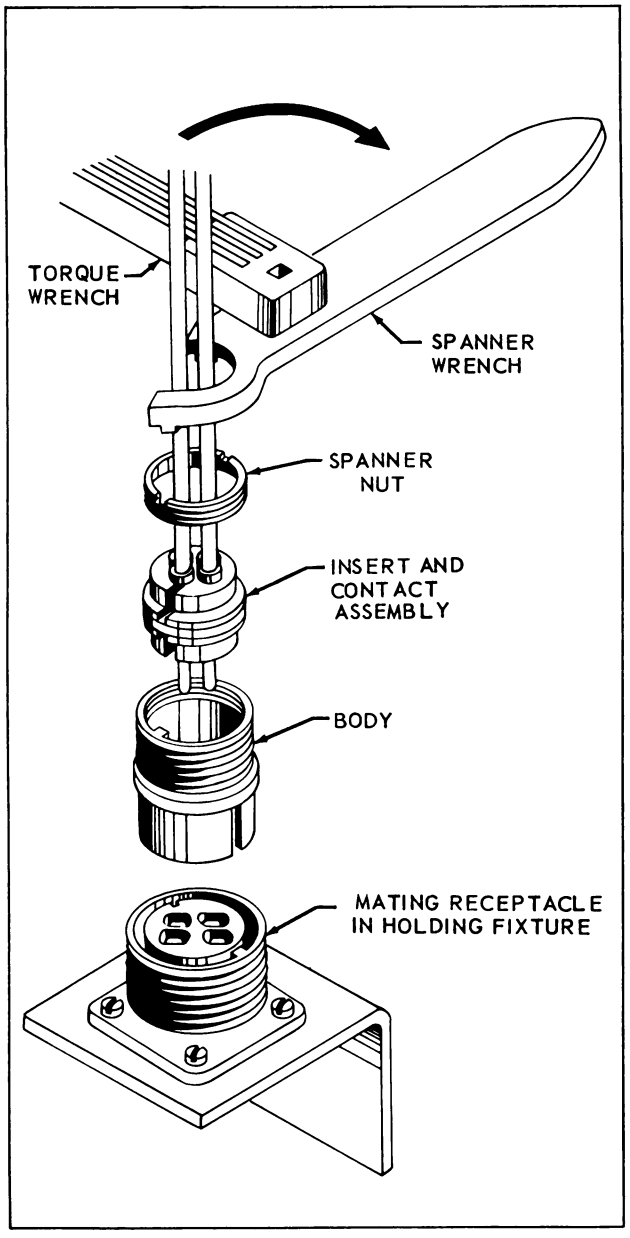


Figure 3–59. Torque Wrench Used on Bendix Fireproof Connector

3–60. CANNON AN CLASS B CONNECTORS. Cannon Class B connectors are supplied with a split shell held together by a shell assembly nut as shown in Figure 3–12. Cannon Class B connectors are installed as follows:

a. Remove split shell by loosening shell assembly nut. Do not remove coupling nut from plug body.

b. If all contacts are size 12 or smaller, no further disassembly is required. For larger contacts see paragraph 3–19a.

c. Install the following items on wire bundle in listed order as shown in Figure 3–60.

1. Cable clamp adapter with loosened saddle.
2. AN3420 telescoping bushing (at least one – extra telescoping sections are added if necessary).

d. Slide insulating sleeves over each wire in bundle. Sleeves should be placed one inch back from

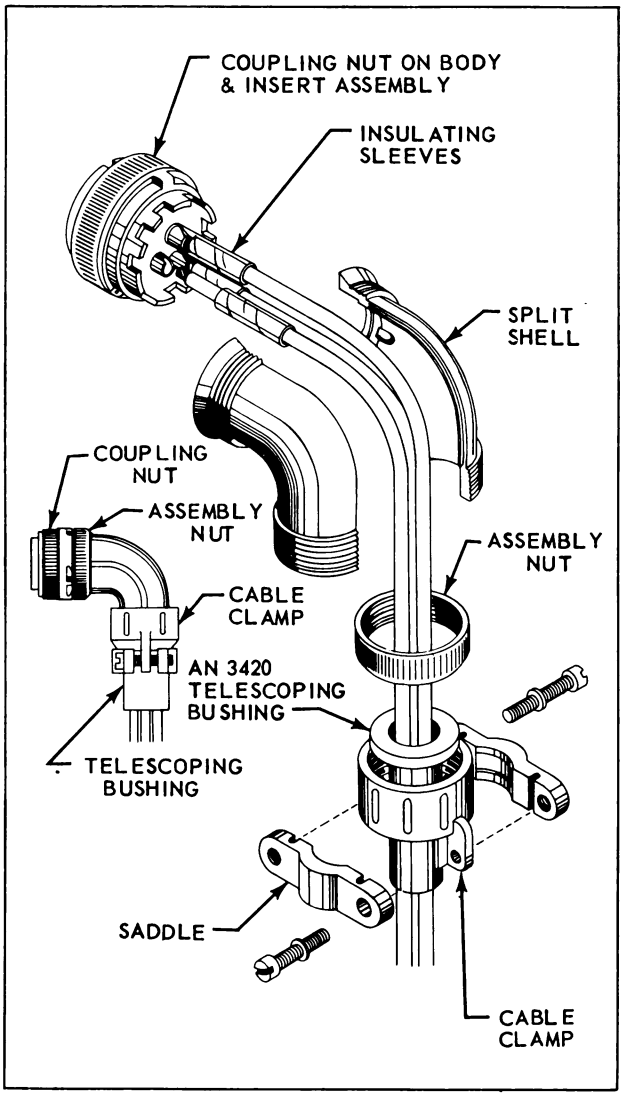


Figure 3–60. Installation of Cannon Class B Connector

wire ends to avoid burning during soldering operation. See paragraph 3–31 for data about insulating sleeves.

e. Solder wires to contacts using processes described in paragraphs 3–34 through 3–38.

f. Clean connections and slide insulating sleeves over contacts until they bottom against insert.

g. Tie sleeves to wires using nylon braid as shown in Figure 3–35.

h. Reassemble split shell. Be careful not to pinch wires.

NOTE

Angle back shells can be locked at any position. See engineering drawing for proper setting for each installation.

i. Install cable clamp as described in paragraph 3–45.

3–61. CANNON AN CLASS C CONNECTORS. Cannon AN Class C connectors are supplied only as receptacles AN 3100C and AN 3102C. These receptacles do not have contacts larger than number 12 size.

CAUTION

Do not remove Class C inserts or contacts. Removal will break the pressure seal.

Install Cannon AN3100C as follows:

a. Remove back shell by unscrewing from body. Slide AN3057A cable clamp, AN3420 telescoping bushing and back shell on the wire bundle in that order.

b. Slide insulating sleeves over each wire in bundle. Sleeves should be placed one inch back from wire ends to avoid burning during soldering operation. See paragraph 3–31 for data about insulating sleeves.

c. Solder wires to contacts using methods described in paragraphs 3–36b through 3–38.

d. Clean connections and slide insulating sleeves over contacts until they butt against the insert.

e. Tie sleeves to wires using nylon braid as shown in Figure 3–35.

f. Slide back shell down over wire bundle and tighten to body. Use strap wrench to tighten back shell 1/8 turn beyond hand tight.

g. Install cable clamp as described in paragraph 3–45. Install Cannon AN 3102C in the same manner as Cannon AN3100C except omit steps a, f and g.

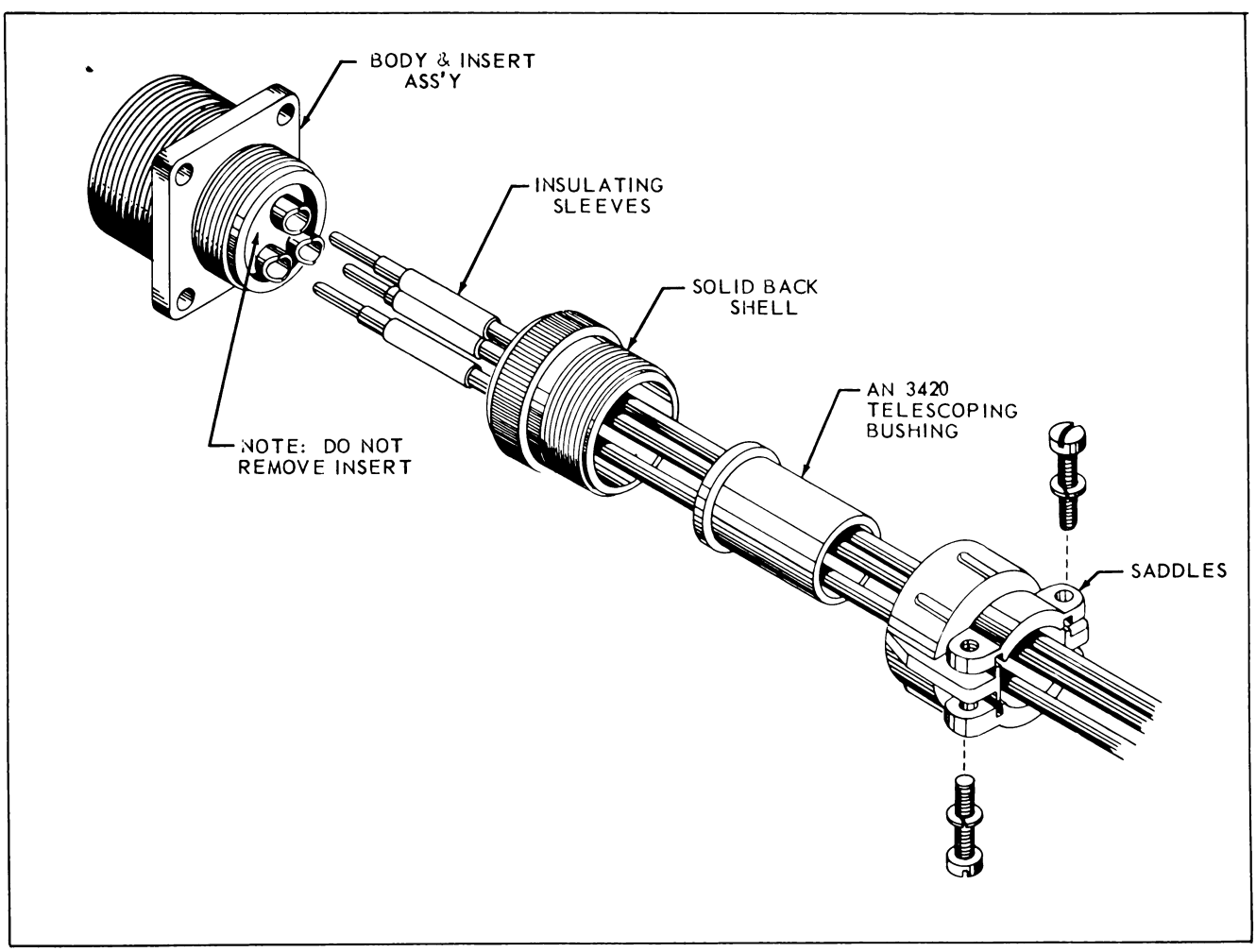


Figure 3–61. Installation of Cannon Class C Connector

3–62. CANNON AN CLASS E CONNECTORS. Install Cannon Class E connectors as follows:

a. Unscrew back shell. Do not pull AN3420 bushings out of back shell. Loosen saddles but do not remove them from back shell.

b. Slide back shell and bushing assembly over wire bundle.

c. Thread pre-tinned wires through grommet follower and also through grommet. Note relationship of grommet follower and grommet in Figure 3–62.

CAUTION

Insert proper wires in holes of grommet and grommet follower. These are coded to match markings on back of insert.

Use alcohol as a lubricant if necessary. After wires are threaded through grommet, use air blast to dry alcohol.

NOTE

Do not install insulating sleeves on wires.

d. Solder wires to contacts as described in paragraphs 3–34 through 3–38. If contacts are larger than number 12 size, they are removed as described in paragraph 3–19c.

e. Reinstall large contacts by pushing them through rear of insert until seated. (See Figure 3–52.) Use alcohol as a lubricant, if necessary. Install each contact, when cool, before proceeding to solder next contact. This will help avoid errors. Use a bakelite screw-driver to aid in seating contacts.

f. Slide grommet down over wire bundle.

CAUTION

Pull lightly on each wire as grommet is seated to prevent wires folding between insert and grommet.

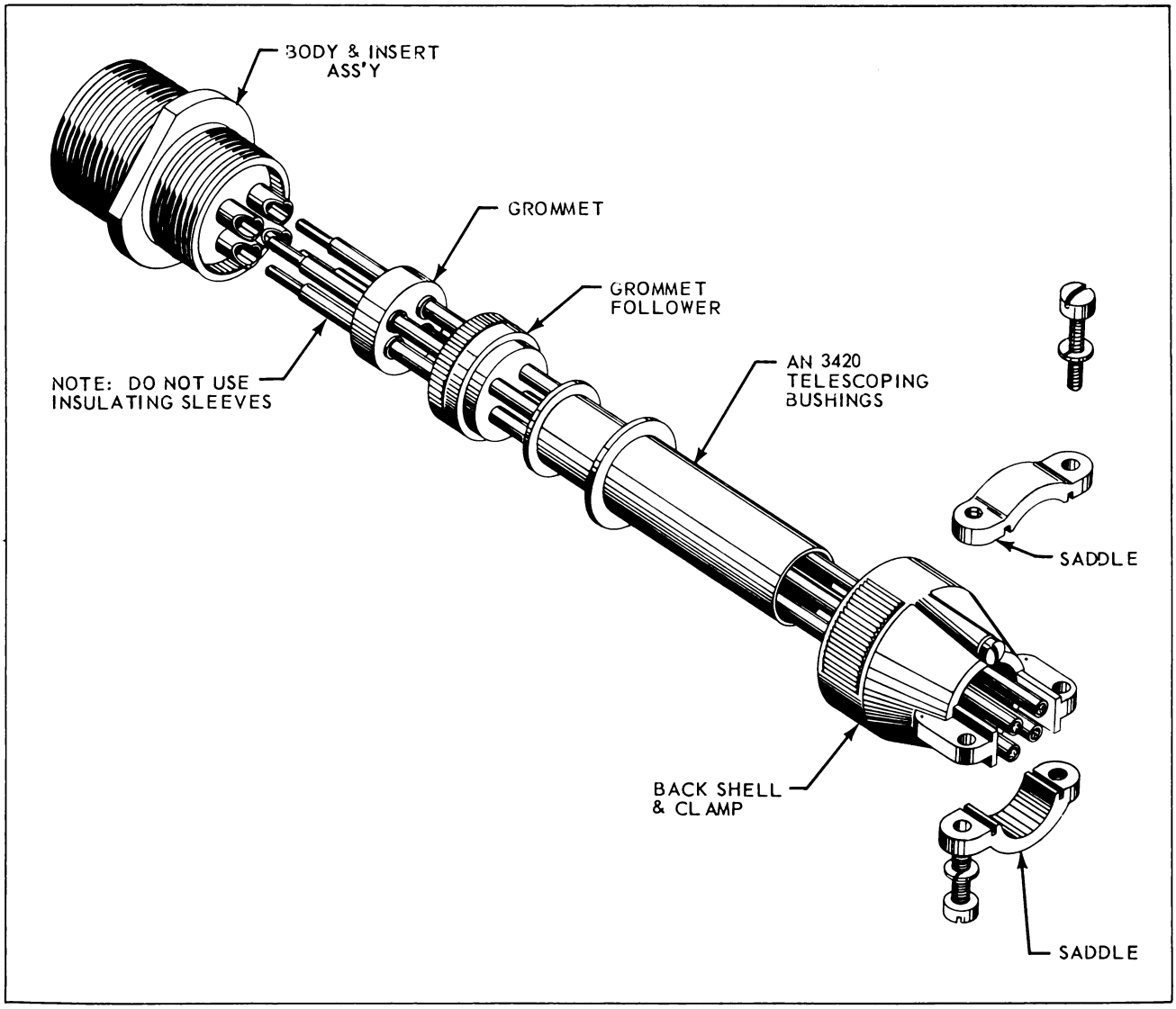


Figure 3–62. Installation of Cannon Class E Connector

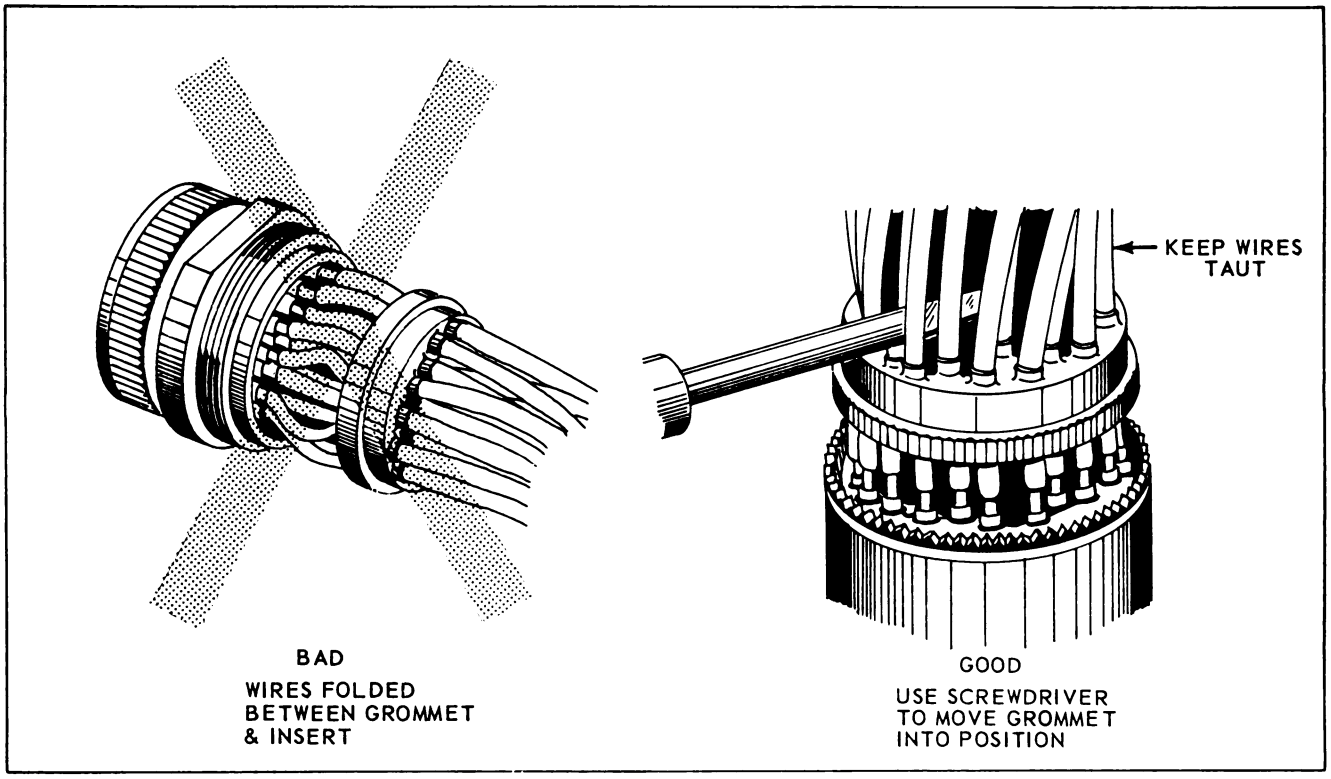


Figure 3–63. Cannon Class E Connector – Grommet Installation

g. Slide grommet follower down over wire bundle. Use same caution as in step f. (See Figure 3–63.)

h. Slide back shell and bushing assembly over wire bundle and hand tighten to body. Use strap wrench to tighten back shell until it bottoms.

i. Tighten saddle screws until 1/16" clearance remains between each saddle and mounting tab of back shell.

3–63. CANNON FIREPROOF CONNECTORS. Cannon fireproof connectors have crimp type contacts to withstand high temperature operating requirements. Installation is as follows:

a. Release back shell by removing four holding screws. Do not remove coupling nut from plug body.

b. Use retaining ring pliers to remove internal retaining ring.

c. Tap connector body in palm of hand to remove inserts. Separate inserts to release contacts.

d. Carefully pull retaining clips from contacts. Do not lose clips.

e. Install the following items on wire bundle in listed order:

1. Back shell with conduit, if required.
2. Retaining ring.

f. Crimp wires into contacts using any of the methods described in Section V.

g. Slide contacts through rear insert. Be careful to get each contact into its proper location by observing the identification letters on the insert.

h. Reinstall the retaining clips to lock contacts into inserts.

i. Push front insert over contacts. Observe identification letters to assure proper location of contacts.

j. Examine contact and insert assembly to see that insert balves butt, and then slide assembly into body.

k. Reinstall retaining ring.

l. Tighten back shell by replacing four holding screws.

m. Tighten conduit coupling nut or other required fitting. Use strap wrench to tighten 1/8 turn beyond hand tight.

3–64. CANNON POTTING CONNECTORS. Cannon potting connectors are supplied with a soft plastic potting mold which is left on the connector after the potting compound has cured. They also have a ground connection strap as shown in Figure 3–65. The ground strap is an extension of the retaining ring which holds the insert in the body.

CAUTION

Do not remove the ground strap even if it is not to be used.

The procedure for Cannon potting connectors is the same as that for Amphenol and Bendix. See paragraph 3–52.

3–65. CANNON DPD CONNECTORS. Cannon DPD connectors have rectangular shells. Their main use is for rack and panel plug-in assemblies. These connectors are not AN but they do have many applica-

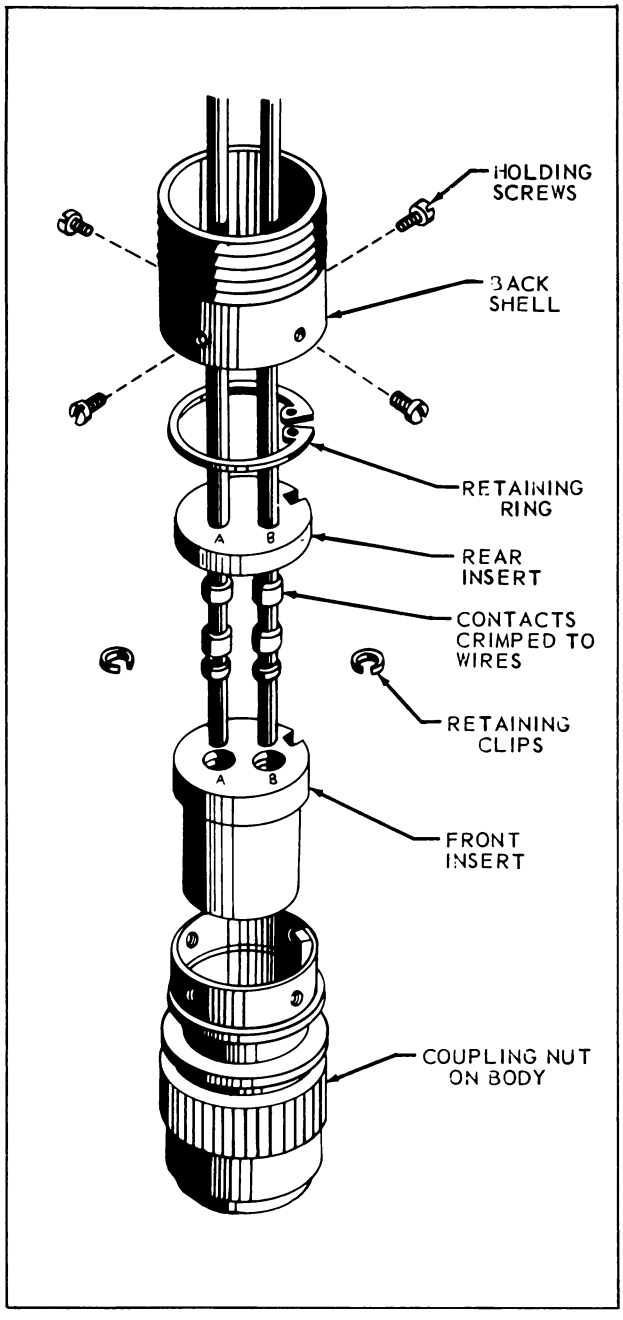


Figure 3–64. Installation of Cannon Fireproof Connector

tions in military aircraft where it is desirable to combine coaxial cable disconnects with general wiring disconnects in one unit. Installation is as follows:

a. Thread bushings (AN3420) if required, into end bell from inside so that flange of bushing rests flush against inside of rear wall of end bell.

b. Slide end bell assembly on wire bundle.

NOTE

Step c. through h. are only for connectors which have coaxial contacts.

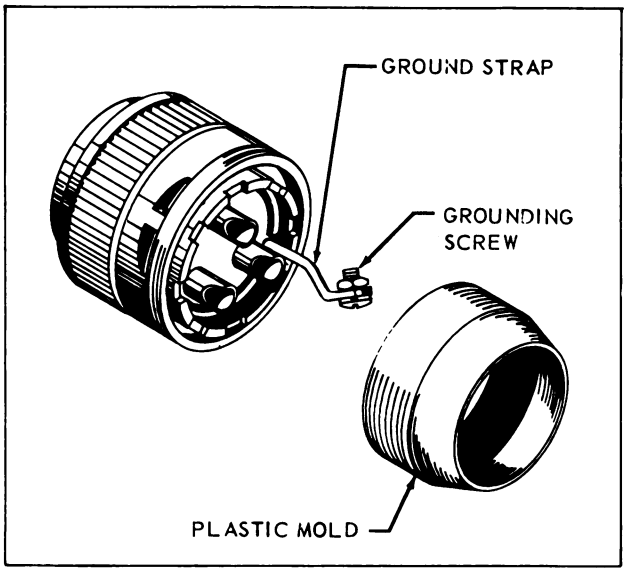


Figure 3–65. Cannon Potting Connector

c. Remove elastic stop nuts on rear of shell to free coaxial contact retaining slips. Coaxial contacts are removed from rear of insert.

d. Strip and prepare coaxial cable following procedures given in Section IV, paragraphs 4–15 through 4–21. See Table XXV for stripping dimensions.

TABLE XXV

Stripping Dimensions for Coaxial Cable

Contact Type	*Cable*	*Strip Length (inches)*		
		A	*B*	*C*
Straight	RG- 7/U	1/8	11/32	15/32
	RG-58/U	1/8	15/32	5/8
	RG-59/U	1/8	15/32	5/8
	RG-62/U	1/8	15/32	5/8
90° Angle	RG- 7/U	3/16	6/16	7/16
	RG-58/U	3/16	15/32	19/32
	RG-50/U	3/16	15/32	19/32
	RG-62/U	3/16	15/32	19/32

e. Remove solder pot cover from contact by prying out with knife.

f. Insert cable and solder center conductor to contact. The dielectric should butt against contact solder pot. Remove flux with Stoddard's solvent.

g. Replace solder pot cover and solder shield to ferrule.

h. Remove flux with solvent. Do not allow solvent to flow under solder pot cover.

i. Solder general purpose wires to remaining contacts in insert. Use procedures described in paragraphs 3–33 through 3–39.

j. Clean rear of insert by brushing with Stoddard's solvent. If rear of connector is to be potted, follow above cleaning with a methylene chloride wash as described in paragraph 3–52e.

CAUTION

Methylene chloride vapors are toxic.

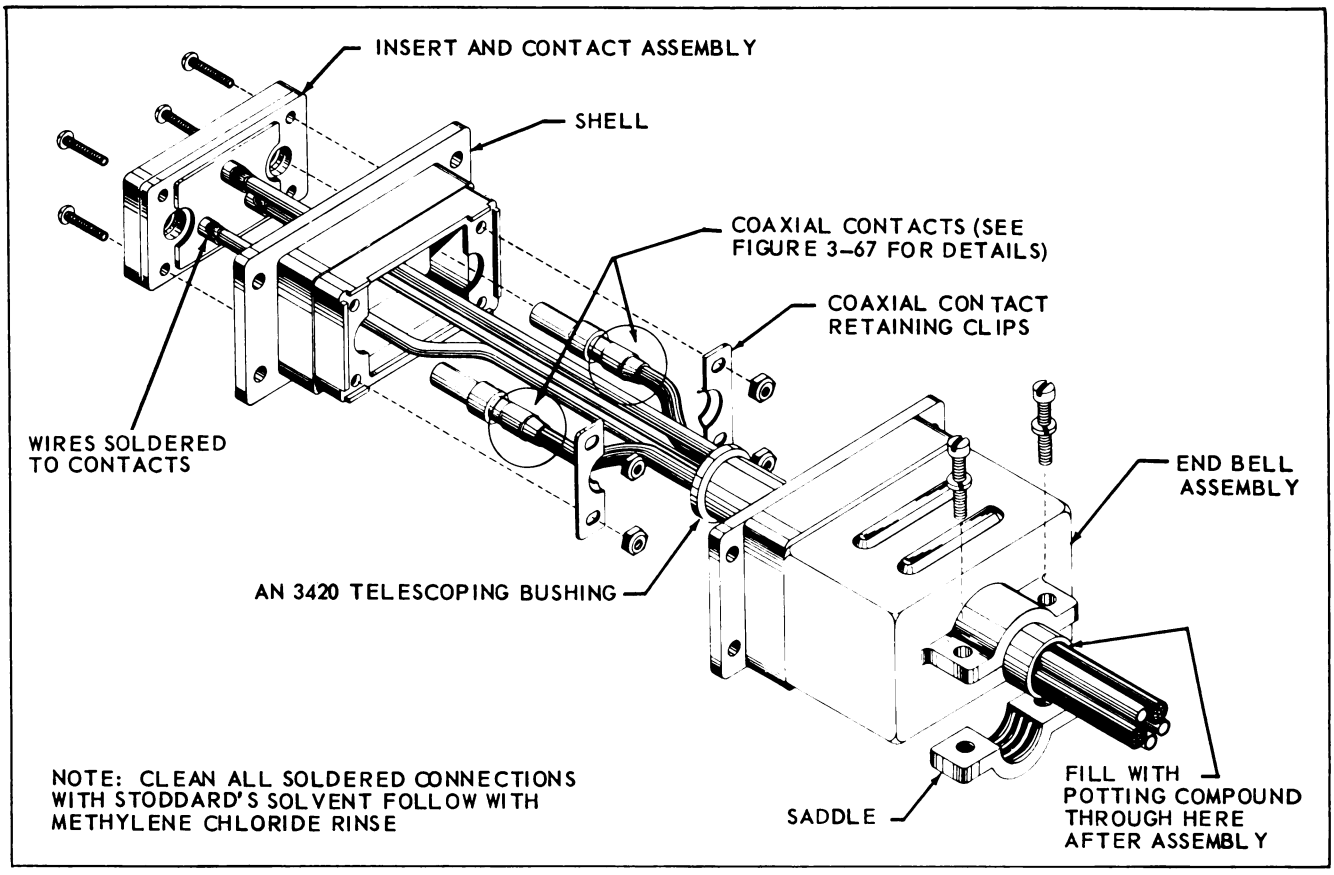


Figure 3-66. Installation of Cannon DPD Connector

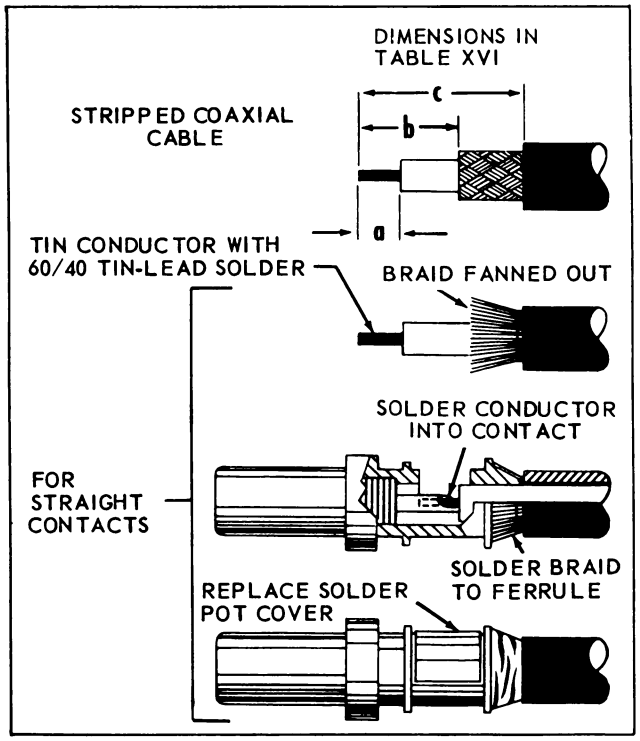


Figure 3-67. (1) Soldering Coaxial Cable to Contacts for DPD Connector

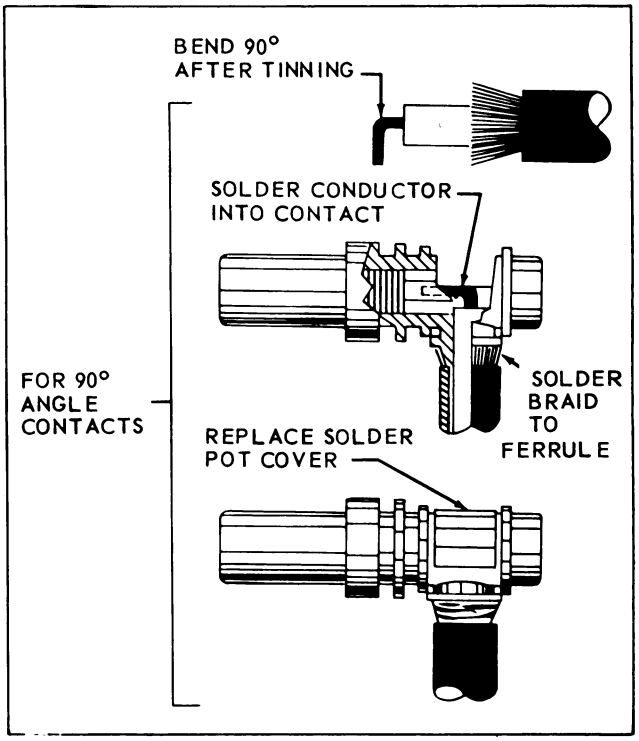


Figure 3-67. (2) Soldering Coaxial Cable to Contacts for DPD Connector

k. Reinstall coaxial contacts and replace retaining clips. Replace stop nuts to hold insert and coaxial contacts in shell.

l. Slide end bell into position and mount to flange of shell.

NOTE

Steps m. and n. apply only to connectors which are to be potted.

m. Push nozzle of potting gun down through telescoping bushing (AN3420) and fill connector back with potting compound. Fill slowly to be sure all air is expelled.

n. Allow potting compound to cure for 24 hours at room temperature (70°F to 75°F).

o. Tighten saddle to compress telescoping bushing (AN3420).

3–66. SUBMINIATURE CONNECTORS. Cannon "U" and Amphenol "26" series connectors are simple subminiatures. The disassembly is fully covered in paragraph 3–24. Solder wires carefully to contacts by use of pencil type resistance soldering iron as shown in Figure 3–26 and described in paragraph 3–34b. Clean off excess flux and reassemble connector by reversing the disassembly procedure. Potting compound is forced through the back shell to provide a good moisture and vibration proof seal. Cure the potting compound for 24 hours at room temperature (70°F – 75°F).

3–67. PREPARATION AND STORAGE OF POTTING COMPOUND.

3–68. HAND MIXING PROCEDURE. Potting compound under MIL–S–8516 is supplied as paired cans of base compound and accelerator. Add the accelerator to the base compound as follows:

a. Remove accelerator lid and with a clean spatula, wood tongue depressor, or putty knife, stir contents slowly into a smooth creamy paste.

b. Cut top from base compound can and stir until material has a smooth texture. This is necessary to recombine any material which may have settled out.

c. Combine accelerator and the base material and thoroughly agitate or mix slowly until no accelerator streaks or traces of unmixed material are visible. This normally requires approximately five minutes. Continued scraping of the sides and corner of the bottom of the container will insure complete mixing. (See Figure 3–68.)

d. Determine if mixing is complete by spreading a drop of the mixture very thinly on a piece of white paper using a knife blade or similar instrument. Very close examination should not reveal any specks or streaks.

e. After above steps have been carefully followed, the sealant is ready for use and may be poured directly into the connector to be sealed in accordance with paragraphs 3–52, 3–57, 3–64, 3–65 and 3–66, above.

f. If the mixed compound is not to be used at once, store in accordance with instructions in paragraph 3-71.

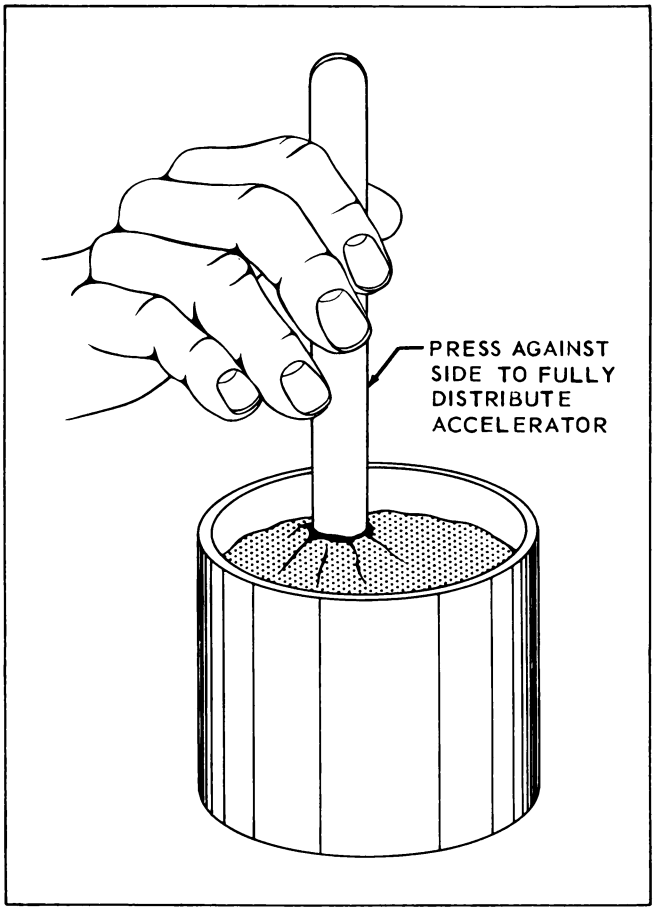


Figure 3–68. Hand Mixing Potting Compound

WARNING

The accelerator contains a lead compound. Avoid excessive skin contact. Clean hands thoroughly after using. Use gloves.

3–69. MECHANICAL MIXING PROCEDURE. Mechanical mixing should be done at 60°F or lower to prolong the working life of the sealant.

a. Hand mix the accelerator as prescribed above. A paint shaker vibrating machine may be used if available. Shake for five to seven minutes.

b. If the base material is packaged in a metal can, cut off the top of the container using a mechanical can opener. This should leave a smooth wall without any burr at the top of the can.

c. Clamp base material container securely to a drill press geared to 50 RPM minimum to 90 RPM maximum. Insert a mixing paddle fashioned from a drill rod and wire. (See Figure 3–69).

d. Start drill press motor and slowly lower mixing paddle into the base compound to recombine any material which may have settled out.

e. Scrape all accelerator from its container and place it in the base material. Start drill press motor again and slowly mix for approximately two minutes. Stop machine, raise paddle and scrape container walls

and paddle as clean as possible. Start the drill press and lower the mixing paddle again and continue mixing for an additional three minutes.

f. Make thin spread of sealant on white paper as described in paragraph 3–68d above. If necessary, continue mixing in two minute cycles followed by paper test until no traces of unmixed material are visible. The sealant is then ready for use.

g. If the mixed compound is not to be used at once, store in accordance with instructions in paragraph 3-71.

3–70. STORAGE OF UNMIXED POTTING COMPOUND. Store base compound and accelerator in a cool place. Shelf life before mixing is approximately one year when stored below 75°F. It is also very important that only the accelerator provided in the container with the base compound be used with that base material.

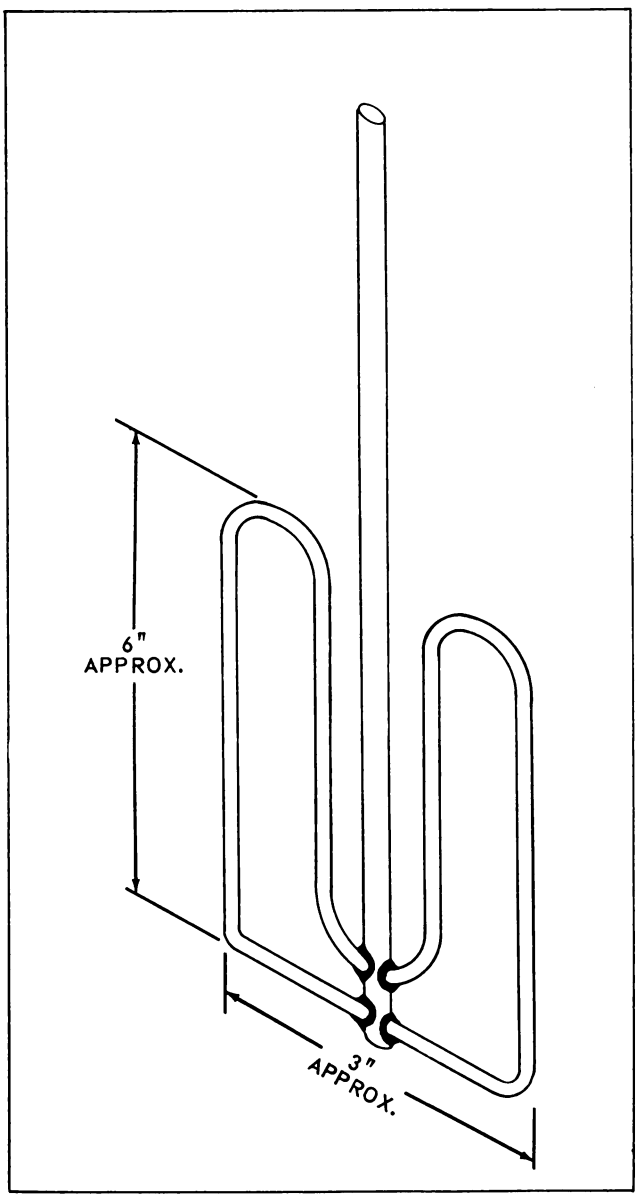


Figure 3–69. Mixing Paddle for Potting Compound

CAUTION

Do not remove the accelerator and base compound from the container to store them separately.

Keep track of manufacturing dates marked on carton. Use oldest material first.

NOTE

Do not use any material which is over one year old.

3–71. STORAGE OF MIXED POTTING COMPOUND. Mixed potting compound can be stored for a maximum of 36 hours in a deep freezer at –20°F. Mixed compound has a 90 minute working life at 75°F and 50% relative humidity. This time is computed from the instant that the accelerator is added to the base compound and must include the time of mixing and use. If the mixed compound is to be stored, it must be cooled quickly and thawed quickly to avoid wasting the short working life. Thaw the mixed compound by blowing compressed air on the outside of the container. Never blow compressed air into the container or use heat to raise its temperature. This compound should be warm enough for use in 5 to 10 minutes.

3–72. DISPENSERS FOR POTTING COMPOUND. Potting compound once mixed should be immediately poured into dispenser tubes made of polyethylene, teflon or aluminum. If necessary to store mixed compound in accordance with paragraph 3–71, the compound should first be poured into the final dispenser tube.

NOTE

Naval activities should follow BuAER EMC No. 89–55 for dispensers.

Aluminum tubes, (Figure 3–70), for use when handling small quantities of potting compound, are similar to toothpaste tubes. These tubes are 2" in diameter and 10" long. Fold over the filling end and seal before storing.

A simple key to wind up the tube and force out the potting compound can be made as shown in Figure 3–70.

3–73. SHIELD & MULTIPLE CONNECTIONS

3–74. CONNECTING SINGLE SHIELDED WIRE TO AN & POTTED CONNECTORS.

Terminate single shielded wires as described in Section II Paragraph 2–58. For connection to Class A, B, C or K connectors, shield must end inside back shell as shown in Figure 3–71. For connection to Class E or potted connectors shield must end outside seal. Crimp pigtail into terminal lug and ground to screw as shown in Figure 3–72, or use permanent splice to join pigtail to short length of AN wire which is then terminated inside connector to contact in regular manner, as shown in Figure 3–73.

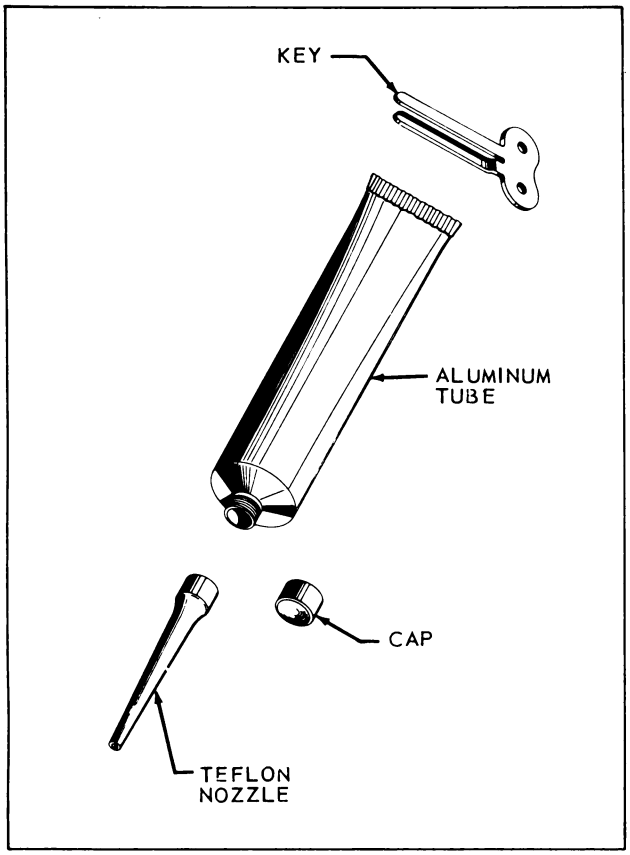


Figure 3-70. Tube Dispenser for Potting Compound

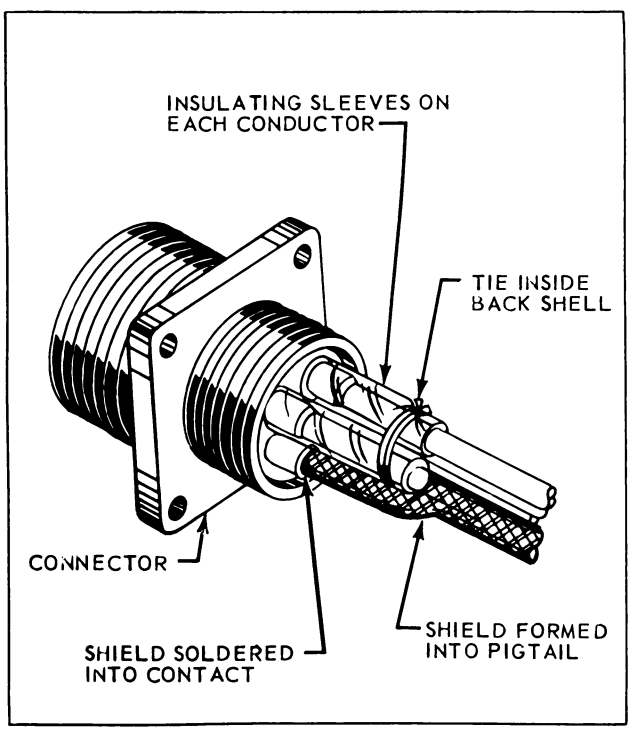


Figure 3-71. Terminating Shielded Wire at "AN" Connector

3-75. CONNECTING SEVERAL SHIELDED WIRES TO AN & POTTED CONNECTORS. Potted connectors which contain shielded wires and all other connectors which have many shields must terminate shields outside the connector. The procedure is as follows:

a. Form pigtail from shield outside connector area. See Section II paragraph 2-58.

1. For potted connector, pigtail should start 1" from end of wire.
2. For other connector, pigtail should start far enough back to remain outside cable clamp.

b. Solder each wire to its contact.

c. Crimp pigtails together into one end permanent splice.

d. Crimp single wire, (doubled if necessary - see section V) into other end of permanent splice.

e. Slide insulating sleeve over splice and tie in place as shown in Figure 3-37.

f. Solder single wire to proper contact in connector as shown in Figure 3-73.

g. Complete connector assembly in normal manner.

An alternate method for grounding utilizes a screw on the cable clamp to ground the shields as follows:

a. Follow steps a and b, above.

b. Crimp pigtails together into solderless terminal lug.

c. Attach terminal lug under screw, as shown in Figure 3-72.

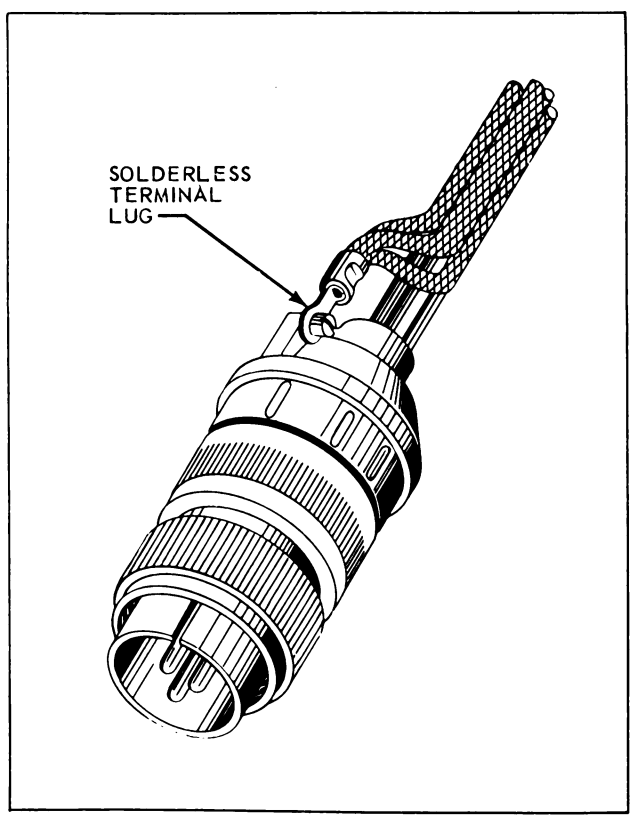


Figure 3-72. Grounding Shields Outside Connector

NOTE

If all shields will not fit into solderless terminal lug, use several terminal lugs and distribute them under both screws.

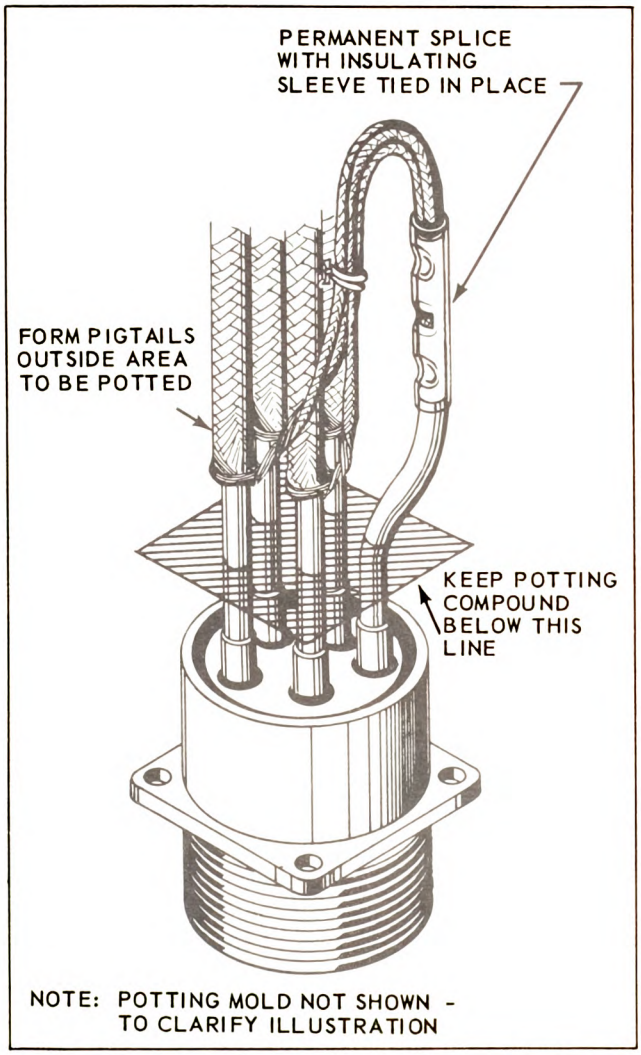


Figure 3–73. Terminating Shielded Wires at Potted Connector

3–76. CONNECTING TWO WIRES TO ONE CONTACT. Connect two wires to one contact by using one of the following methods:

a. If both wires can be fitted into contact solder cup, proceed as with single wire. Slide insulating sleeve over both wires together and insert them into solder cup. Be sure all strands are inside cup before soldering. When solder has cooled push insulating sleeve down until it butts against insert. See Figure 3–74.

b. If both wires cannot fit into contact solder cup, use permanent splice to join both wires to a third wire which can fit into solder cup. See Section V, paragraph 5–55 for splicing procedure and Figure 3–75 for illustration of this connection.

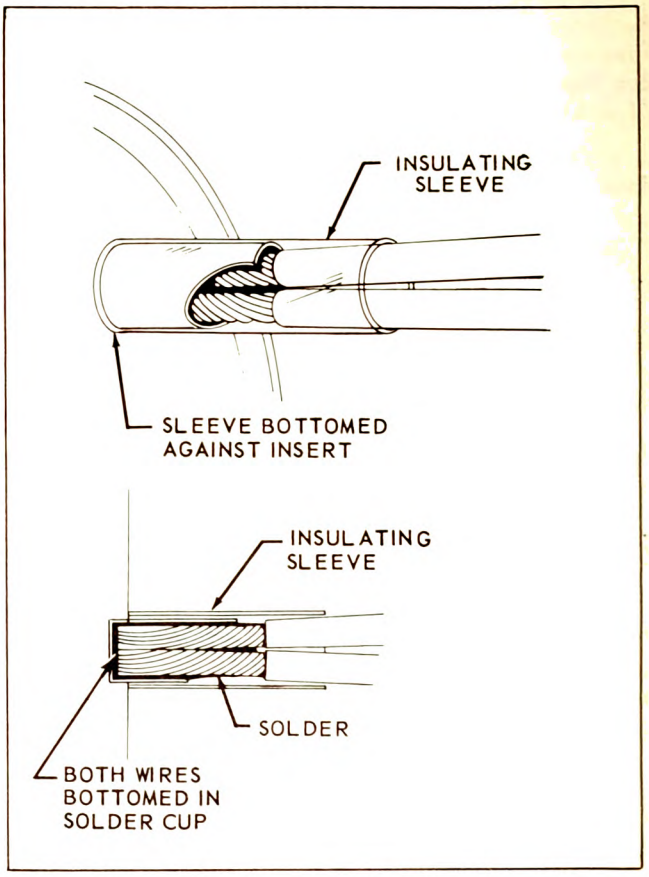


Figure 3–74. Terminating Two Wires at One Contact

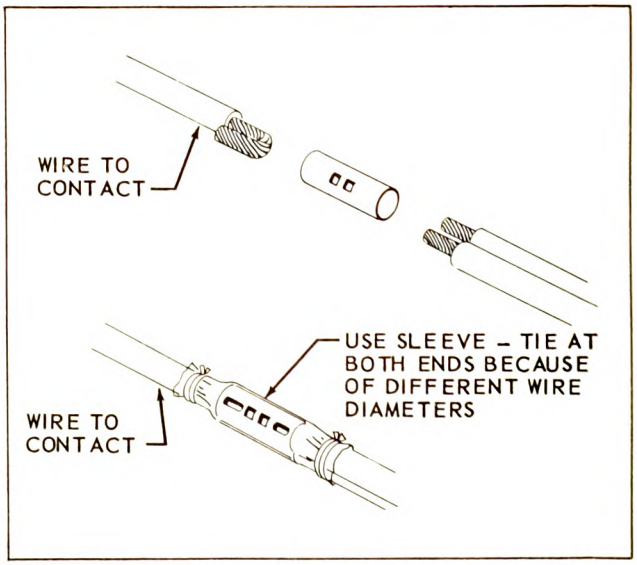


Figure 3–75. Permanent Splice for Terminating Two Wires at One Contact

CAUTION

The use of a single wire to terminate two wires at a connector must be approved by engineering. The current carrying capacity of the single wire must not be exceeded.

3-77. REDUCING WIRE SIZE AT AN CONNECTOR. Reduction of wire size to enable a larger diameter wire to be soldered to a smaller diameter contact solder cup requires engineering approval. A safe method of making the reduction is as follows:

a. Select a permanent splice which will accomodate the larger wire. Crimp this splice to the stripped wire as described in Section V, paragraphs 5-52 through 5-59.

b. Slide an insulating sleeve, large enough in diameter to pass over the permanent splice, clear of the connection. (Only if uninsulated splice is used.)

c. Select a six inch length of AN wire which will fit the solder cup of the contact. Strip one end sufficiently long to be able to double the stripped portion back on itself as shown in Figure 3-76.

d. Crimp this doubled wire into the free end of the permanent splice.

e. Slide the insulating sleeve into position (if used) and tie at both ends with nylon braid.

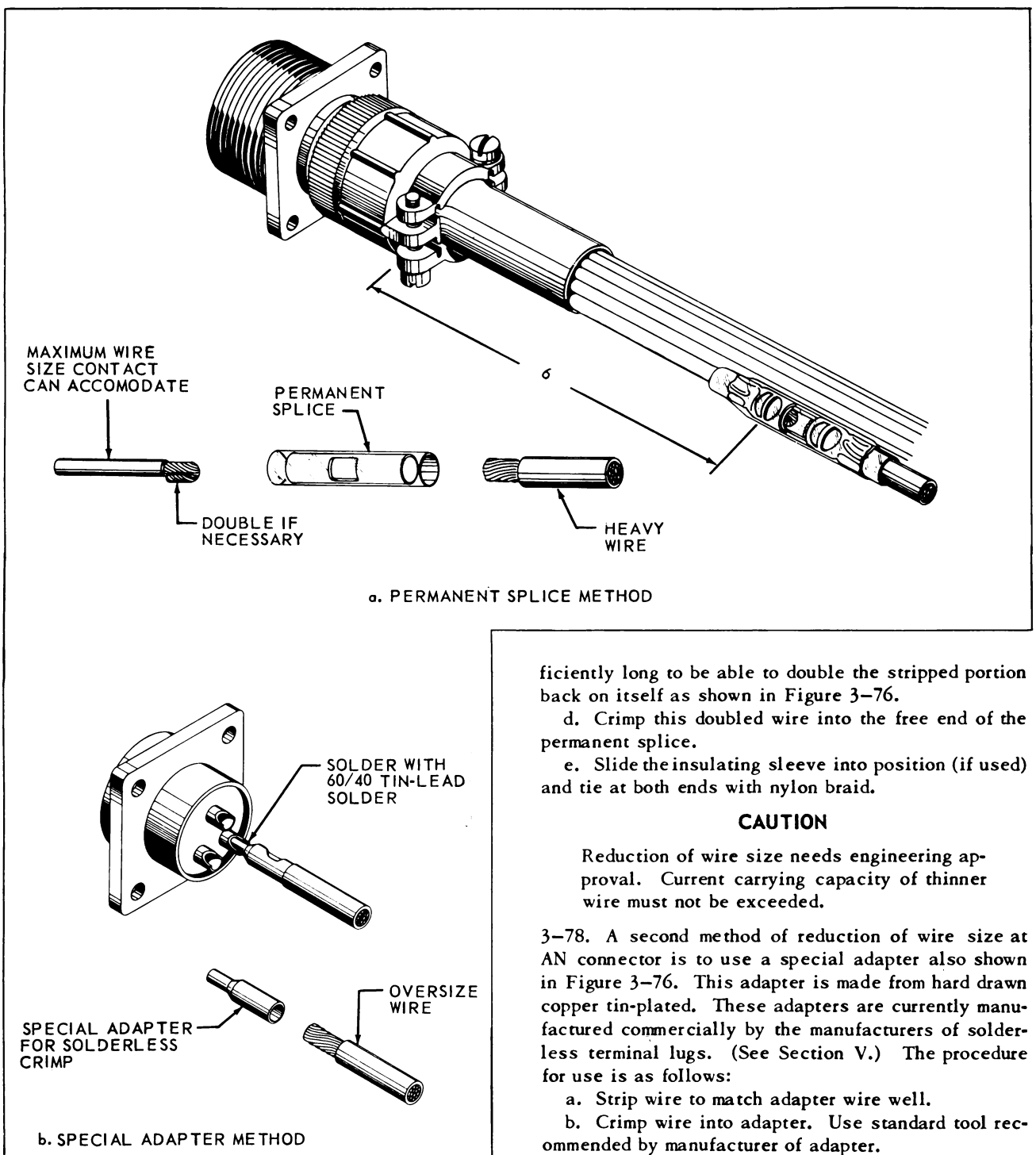


Figure 3-76. Reducing Wire Size at "AN" Connector

CAUTION

Reduction of wire size needs engineering approval. Current carrying capacity of thinner wire must not be exceeded.

3-78. A second method of reduction of wire size at AN connector is to use a special adapter also shown in Figure 3-76. This adapter is made from hard drawn copper tin-plated. These adapters are currently manufactured commercially by the manufacturers of solderless terminal lugs. (See Section V.) The procedure for use is as follows:

a. Strip wire to match adapter wire well.

b. Crimp wire into adapter. Use standard tool recommended by manufacturer of adapter.

c. Solder adapter into contact. Use 60/40 tin-lead, rosin core, solder.

SECTION IV

RF CONNECTORS AND CABLING

4–1. INTRODUCTION.

4–2. SCOPE. This section describes recommended methods for assembling to coaxial cable five series of rf connectors most commonly used in aircraft. These five series are:

a. BNC Series. See Figure 4–1. A small, lightweight, bayonet type, quick-connect/-disconnect connector, used with small rf cables, where peak voltage is not more than 500 volts.

b. HN Series. See Figure 4–2. A high voltage (up to 5,000 volts), threaded coupling connector used with medium size rf cables.

c. N Series. See Figure 4–3. A general purpose, threaded coupling connector used with medium size rf cables.

d. C Series. See Figure 4–4. A late model, bayonet type, quick-connect/-disconnect connector used with medium size rf cables. It is electrically similar to the N Series.

e. Pulse Series. See Figure 4–5. A high-voltage connector for pulse or dc applications. Designed for use with rubber-dielectric pulse cables, but may be used with equivalent-size cables of other construction where high voltage is not required. With ceramic inserts peak voltage is 15000 v. at sea level. With rubber inserts peak voltage is 5000 v. at 50000 feet, but higher voltages may be used at lower altitudes.

4–3. PURPOSE. Coaxial cable assemblies are used to carry rf (radio frequency) power from one point to another with a known rate of loss. An assembly consists of rf connectors attached to coaxial cable.

4–4. RF CONNECTORS. RF connectors are available as plugs, jacks and panel jacks. Plugs and jacks are attached to the ends of coaxial cables while panel jacks are mounted to panels or chassis. Some panel jacks are fastened by means of four screws through holes in a plate integral with the jack body (See Figure 4–1). Other panel jacks are fastened by means of a single nut threaded over the jack body (See Figure 4–4). Plugs always have male contacts; jacks and panel jacks always have female contacts.

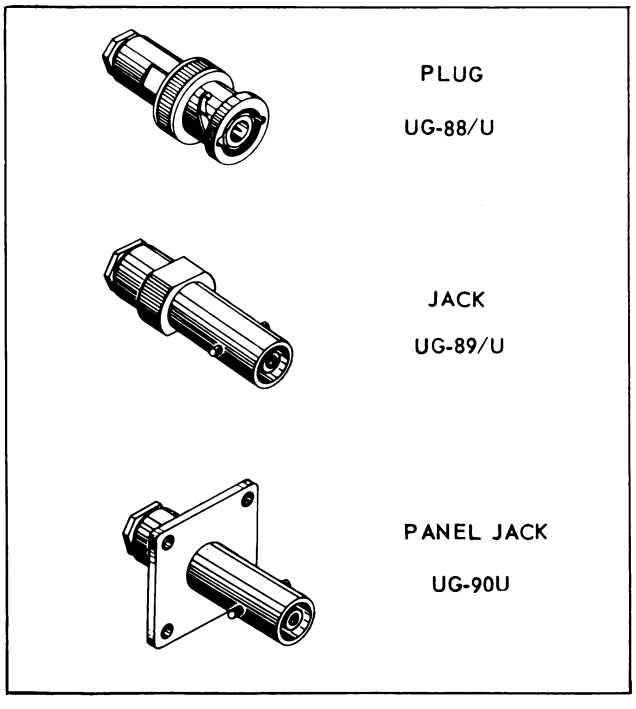


Figure 4–1. Typical BNC Connectors

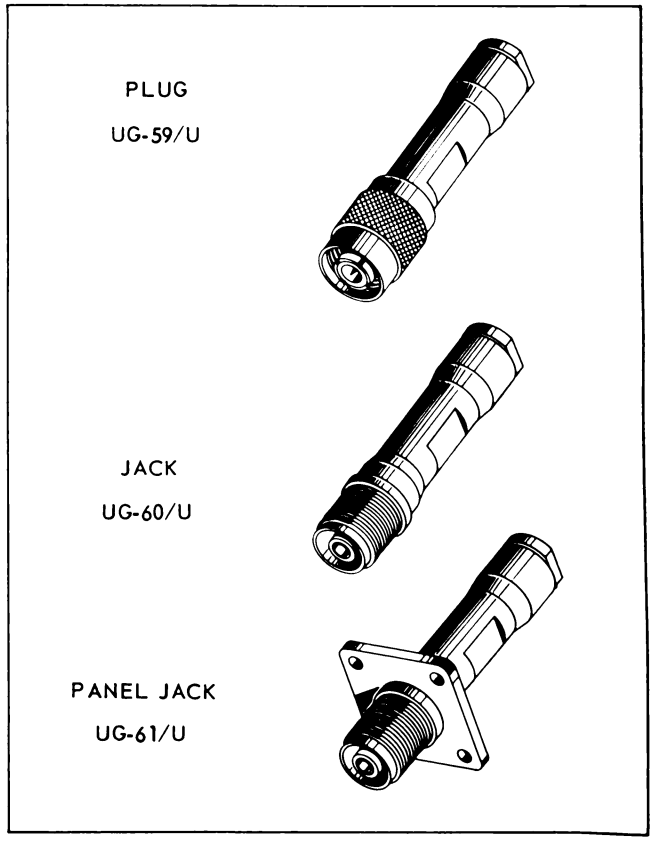


Figure 4–2. Typical HN Connectors

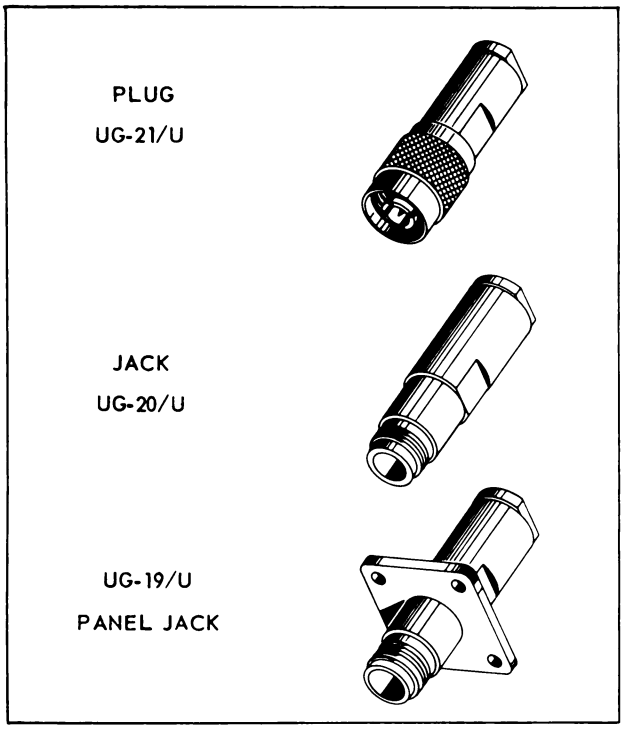


Figure 4–3. Typical N Connectors

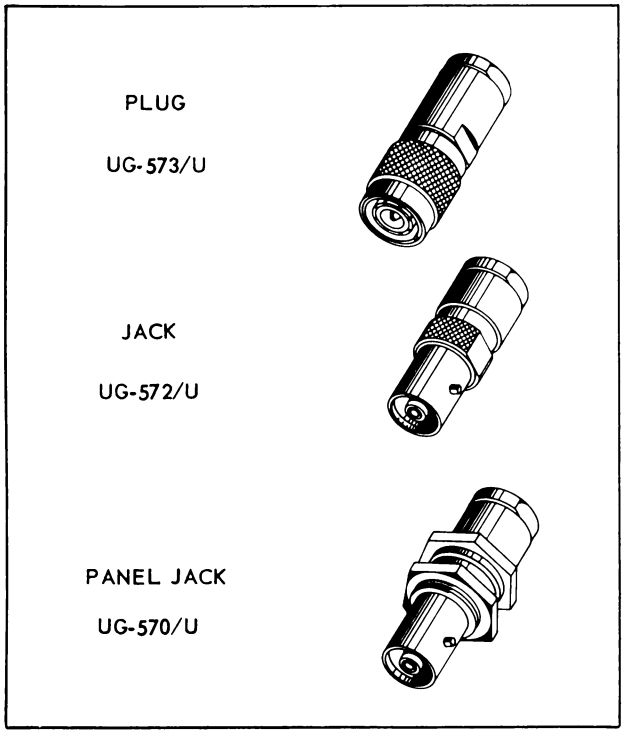


Figure 4–4. Typical C Connectors

4–5. COAXIAL CABLE. Coaxial cable consists of a center conductor separated from the outer conductor, usually called a "shield", by an insulating dielectric. The cable is protected against moisture and abrasion by a tough outer jacket. See Figure 4–6 for typical

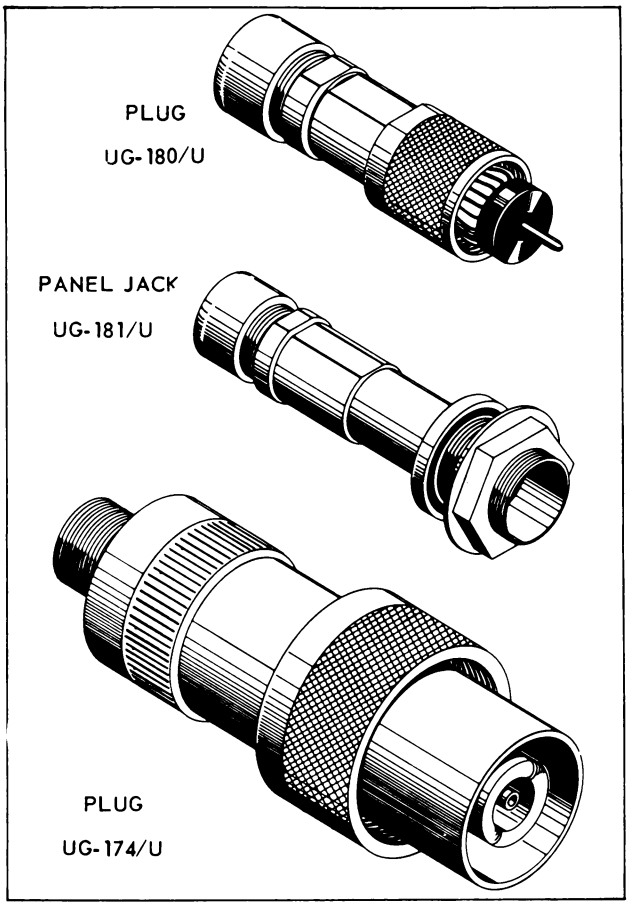


Figure 4–5. Typical Pulse Connectors

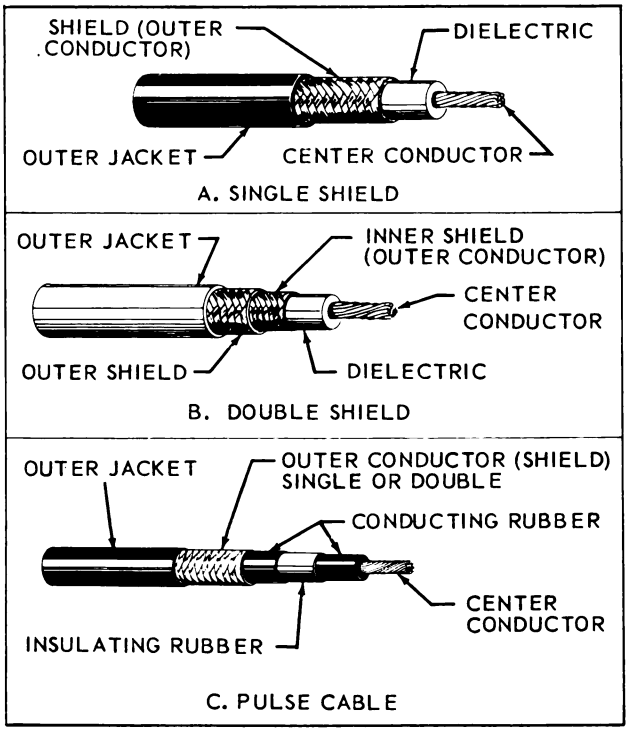


Figure 4–6. Typical Coaxial Cables

coaxial cables. The center conductor is usually copper, either solid or stranded, and may be bare, tin plated or silver plated. The outer conductor (shield) is usually a copper braid, bare, tin plated or silver plated, woven over the dielectric. Some coaxial cables have a double outer conductor (double shield) to provide extra shielding. The dielectric has two functions: (1) it provides low loss insulation between the center conductor and the outer conductor, (2) it maintains the relative position of the center conductor inside the outer conductor and therefore keeps the capacitance between the two at a constant value.

4–6. REFERENCE SPECIFICATIONS AND DOCUMENTS.

QQ-S-57	Solder, Soft, (tin, tin-lead, lead-silver)
MIL-C-71	Connectors, "N" for RF Cables
MIL-I-631	Insulation, Electrical, synthetic-resin composition, non-rigid
MIL-C-3607	Connectors, Pulse, for RF Cables
MIL-C-3608	Connectors, "BNC", for RF Cables
MIL-C-3643	Connectors, "HN", for RF Cables
MIL-W-5088	Wiring, Aircraft, Installation of
MIL-A-6091	Alcohol, specially denatured Ethyl
MIL-S-6872	Soldering Process, General Specifications for
MIL-I-8660	Insulating and Sealing Compound, electrical
JAN-C-17	Cables, coaxial, for RF
JAN-T-713	Twine, lacing and tying, electrical
ASESA 49-2B (NAVSHIPS 900.102)	Armed Services Index of R.F. Transmission Lines and Fittings

4–7. GENERAL PRECAUTIONS AND PROCEDURES.

4–8. GENERAL PRECAUTIONS. A good connection depends on holding coaxial cable and its connectors to the design dimensions. Any change in these dimensions will cause added losses to the rf power being carried, and may also cause radiation interference. It is important that the assembly directions given for each connection be carefully followed to avoid trouble. These precautions are common to all assemblies of coaxial cable and rf connectors.

4–9. When working with coaxial cable, never step on the cable, set anything heavy on it, or bend it sharply. This will flatten the cable and will change its electrical characteristics. Handle coaxial cable carefully at all times. Anything which damages it, or which might lead to its being damaged later, reduces the efficiency of the system.

4–10. Never use pliers for any connector assembly or disassembly operation.

4–11. Contacts for rf connectors are usually packed unassembled. Do not misplace them.

4–12. When attaching connectors to coaxial cable having a double shield, be sure both shields are soldered together at connector.

4–13. Use care in starting the nut into a plug or jack body, in order to prevent cross threading.

4–14. Keep soldering iron clean, smooth, and well tinned at all times. See paragraphs 4–25 through 4–28 for care of soldering iron.

4–15. GENERAL PROCEDURES. During the preparation of coaxial cable assemblies, observe the following general procedures.

4–16. Cut coaxial cable to length with a fine tooth (20 teeth per inch) saw, making sure cut is clean and square. See Figure 4–7. Use a saw vise to retain the circular shape of the cable.

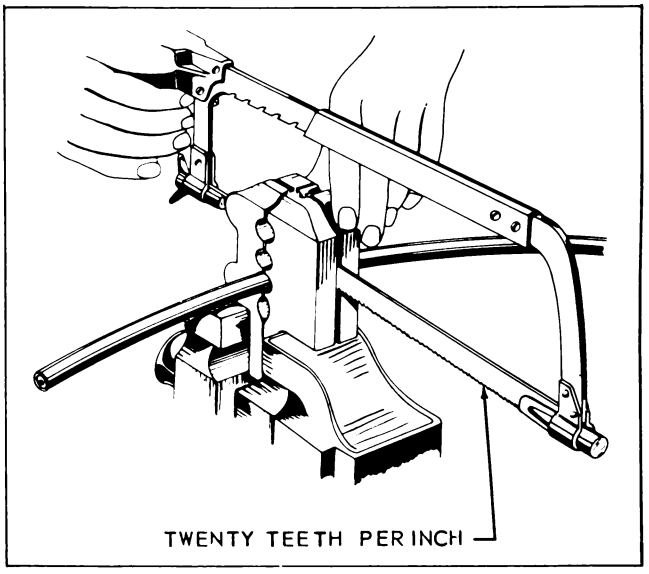


Figure 4–7. Cutting Coaxial Cable

4–17. Identify cable by using the techniques described in paragraph 2–18.

4–18. Strip outer jacket from cable by first making a cut carefully around circumference with a sharp knife. See Figure 4–8, step a. Then make a lengthwise slit, step b, and peel jacket, step c. Take care not to nick, cut or damage shield.

4–19. Comb out the braid by using a pointed wooden dowel, (orange stick), or a scriber.

CAUTION

Do not damage dielectric or break shield strands.

4–20. To remove dielectric, cut with sharp knife around circumference, not quite through to center conductor, taking care not to nick or cut strands, or otherwise damage conductor. Pull off dielectric. Another method of stripping the dielectric is to use a soldering iron to which a strip of sheet copper has been fastened as shown in Figure 4–9. The dielectric to be stripped is laid in the "V" and rotated. This will melt a clean break that permits the dielectric to be easily removed by hand.

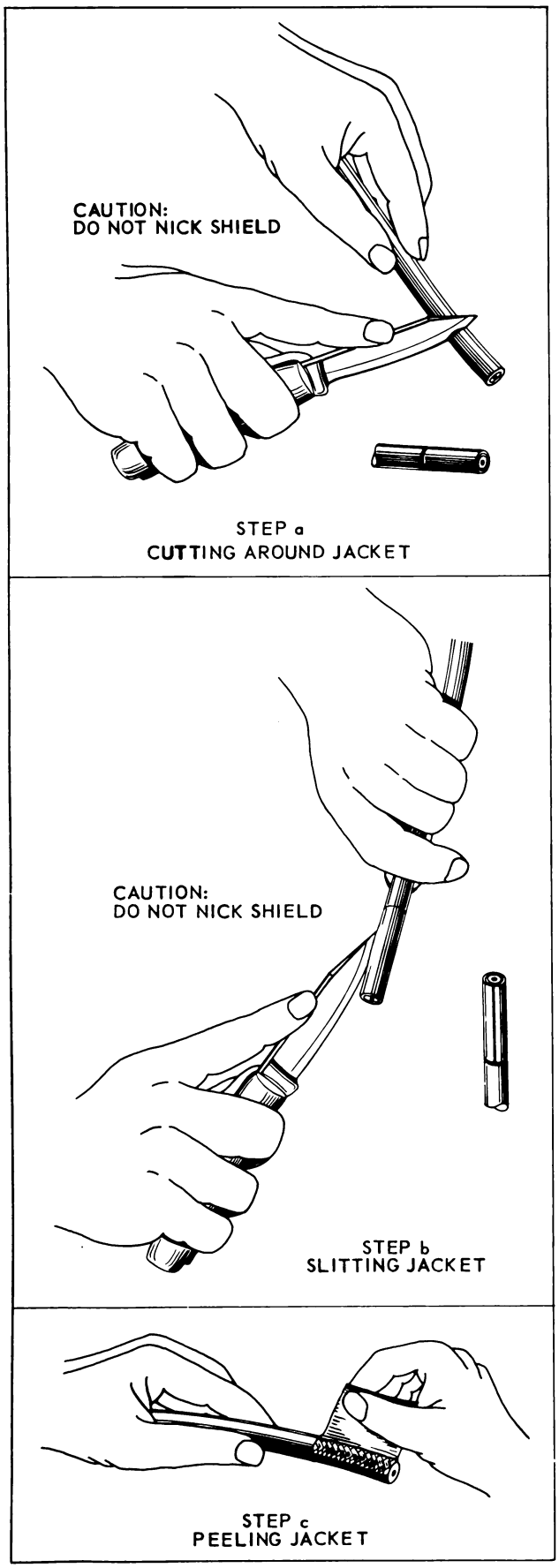


Figure 4–8. Stripping Outer Jacket from Coaxial Cable

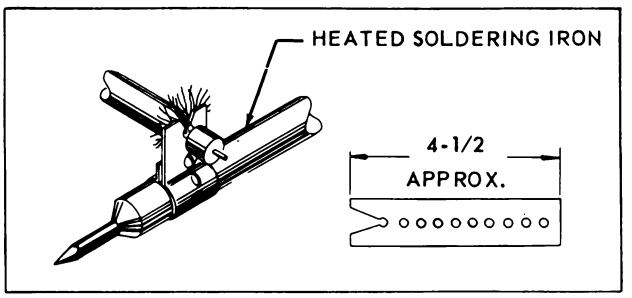


Figure 4–9. Improvised Dielectric Stripper

4–21. Tin center conductor with soldering iron as shown in Figure 4–10.

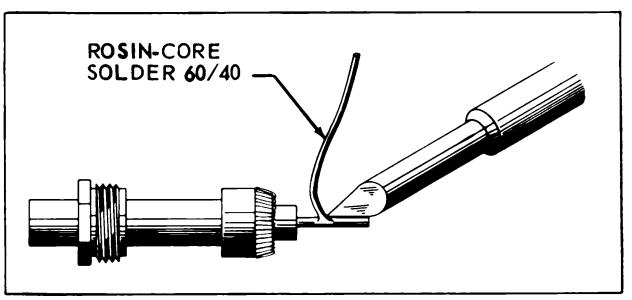


Figure 4–10. Tinning Center Conductor

4–22. Tin inside of contacts (male or female) with soldering iron, as shown in Figure 4–11. (Use untinned face of tip to prevent depositing solder on outside of contact.)

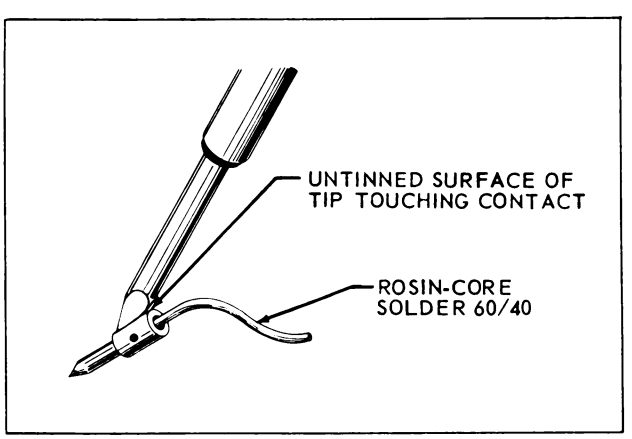


Figure 4–11. Tinning Inside of Contact

4–23. Solder contacts (male or female) to center conductor with clean, well tinned, soldering iron using 60/40 tin-lead, rosin-core solder. See Figure 4–12. Do not apply heat too long as this will swell the dielectric and make it difficult to insert into the body shell. After soldering, if there is excess flux on outside of contact or dielectric, remove it with denatured alcohol. Do not allow solder to flow over outside of contact.

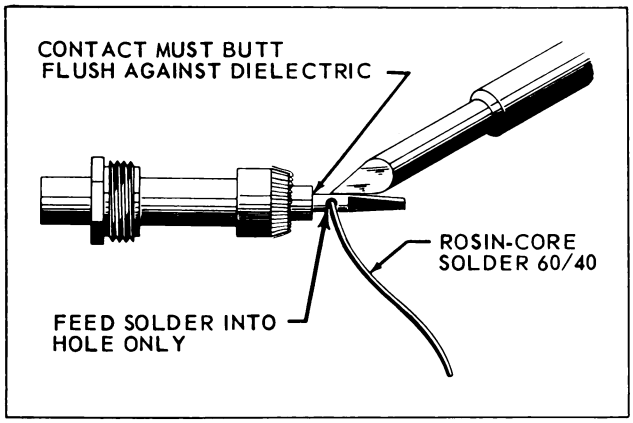


Figure 4–12. Soldering Contact to Coaxial Cable

CAUTION

Contact must butt flush against dielectric before and after soldering.

4–24. When assembling the connector always start the clamping nut into the body by hand, then hold the body assembly in a vise using lead or neoprene jaw protectors. See Figure 4–13. Hold body only on the flats. Do not use excessive pressure, since the body can be easily distorted. Tighten nut with end wrench.

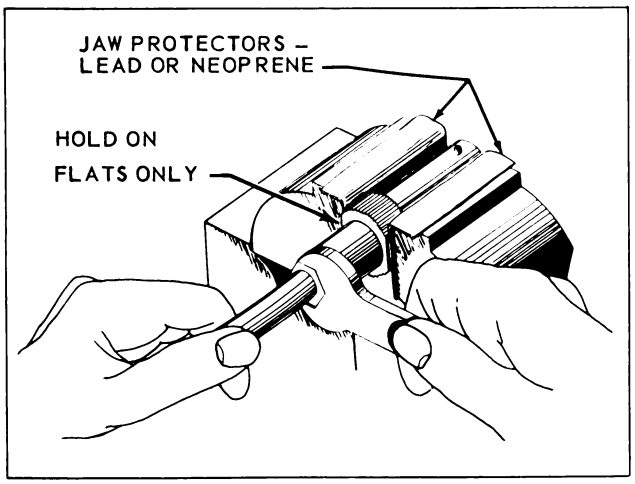


Figure 4–13. Tightening Nut into Plug or Jack Body

4–25. CARE AND USE OF SOLDERING IRON.

4–26. SELECTING SOLDERING IRON. The efficiency of electric and electronic equipment is dependent, to a very great extent, on the quality of the workmanship employed and on the type of material used in the soldering of its electrical connections. For good soldering it is important to choose the proper size soldering iron. Select an iron of large enough heat capacity to heat the mass of metal to the alloying temperature. The iron must not be too big because excessive heat may melt insulation. For the operations in this chapter, select an iron with a tip of about 1/4 inch diameter and a heating element rated at 65 to 100 watts. The soldering tip should be shaped as shown in Figure 4–14. Maintain this shape by dressing the tip with a mill smooth file.

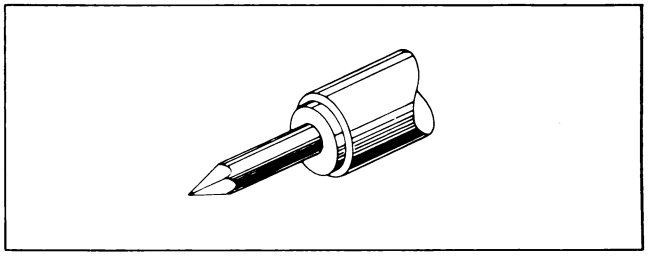


Figure 4–14. Correct Shape for Soldering Iron Tip

4–27. TINNING SOLDERING IRON TIP. Tin the tip in order to properly transfer the heat from the soldering iron tip to the work. To tin a tip, it must first be clean and bright. Tin only one face of the tip so that areas adjacent to that being soldered will not be coated with solder by accident. Tin the iron by rubbing rosin-core 60/40, tin-lead, solder on the clean iron as it reaches operating temperature. Do not let iron get too hot before tinning. When applying solder for tinning the tip, hold the iron so that the surface of the tip is turned away from your face. Burns from molten solder or hot rosin flux are painful.

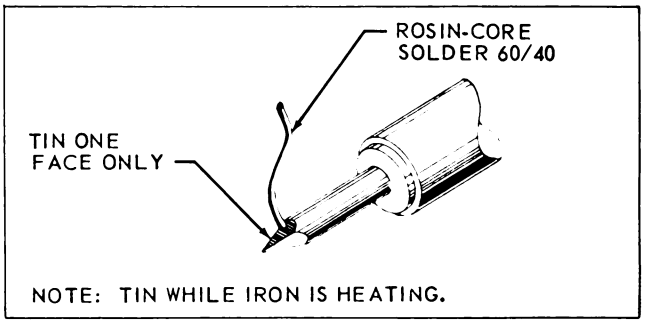


Figure 4–15. Tinning Soldering Iron Tip

About once a day remove the tip from the soldering iron and clean out the black scale which collects inside the barrel of the iron. This will aid the transfer of heat from the iron to the tip and also prevent the tip from "freezing" in the iron. When an iron is new, or a new tip is installed, coat the inside end of the tip shank with dry flake graphite to prevent "freezing". When finished with a soldering job, wipe excess solder from the tip while still hot. This will minimize pitting.

4–28. USE OF SOLDERING IRON. Only one flux will not cause or aid corrosion. That flux is pure water white rosin, dissolved by alcohol into a paste. The work to be soldered must be clean and free from grease and oxides. Grease is removed by cleaning with a solvent such as Stoddard's Solvent and wiping dry. Oxides, if not too heavy are removed by the action of the rosin flux during the soldering operation. Heavily

oxidized wire cannot be cleaned by rosin flux and should be discarded. The usual solder is an alloy of 60% tin and 40% lead extruded in wire form with a core of rosin flux. Solder is applied to the parts to be joined after heating them with a soldering iron. The solder is best applied at the junction of the tinned tip and the work. This forms a bridge of molten metal which helps to transfer the proper amount of heat to the joint. See Figure 4-10. After the joint has cooled, remove excess flux by wiping with a clean cloth. Use alcohol as a solvent, if necessary. If excess solder is deposited on the contact, remove by scraping with a knife. Be careful not to cut into contact or dielectric.

4-29. BNC SERIES CONNECTORS.

4-30. BNC CONNECTOR TYPES. There are three versions of BNC connectors. These versions differ in the method of securing the coaxial cable to the connector body. See Figure 4-1 for typical examples of BNC connectors. Table XXVI lists the more common connectors in the BNC series and shows the coaxial cables associated with each.

a. Standard Version (see Figure 4-16) - consists of a plug or jack body assembled to coaxial cable with nut, washer, gasket and clamp. Plug UG-88/U and Jack UG-89/U are typical of this version.

b. Modified Standard Version (see Figure 4-17 - similar to the standard version and using the same nut, but a one-piece clamp and gasket takes the place of the washer, gasket and clamp. Plug UG-88B/U and Jack UG-89A/U are typical of this version.

TABLE XXVI

BNC Series Connectors With Associated Cables

Plug	*Jack*	*Panel Jack*	*Cable*
UG-88/U (*)	UG-89/U (*)	UG-90/U (*)	
UG-88B/U (**)	UG-89A/U (**)	UG-291/U (*)	RG-55/U double shield
UG-88C/U (***)	UG-89B/U (***)	UG-291A/U(**)	RG-58/U single shield
		UG-291B/U (***)	
UG-260/U (*)	UG-261/U (n)	UG-262/U (*)	RG-59/U single shield
UG-260A/U (**)	UG-261A/U (**)	UG-262A/U (**)	RG-62/U single shield
UG-250B/U (***)	UG-261B/U (***)	UG-262B/U (***)	RG-71/U double shield

(*) Standard Version; (**) Modified Standard Version; (***) Improved Version

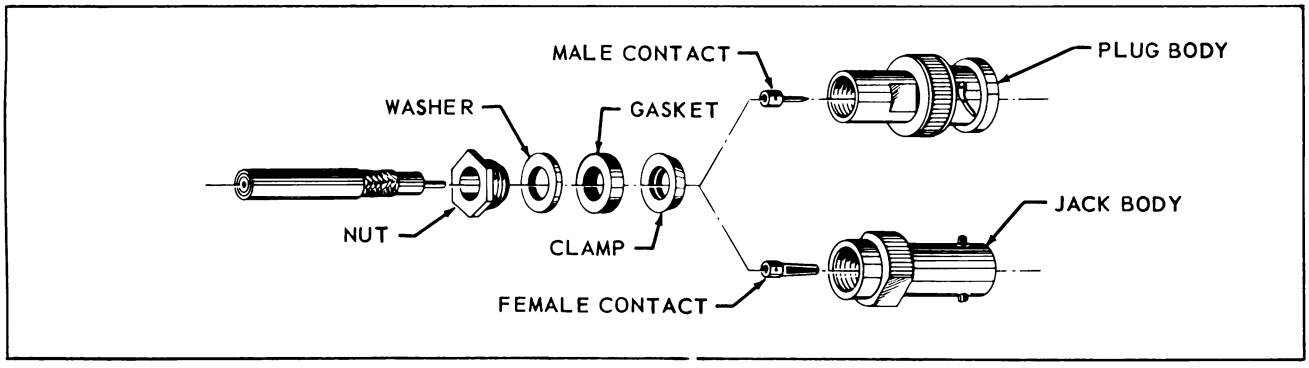


Figure 4-16. Standard BNC Connectors - Exploded View

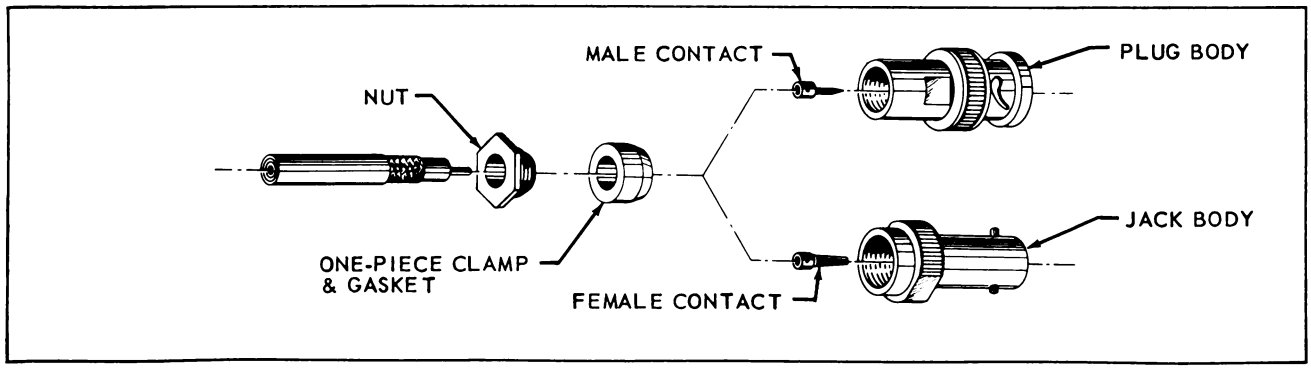


Figure 4-17. Modified Standard BNC Connectors - Exploded View

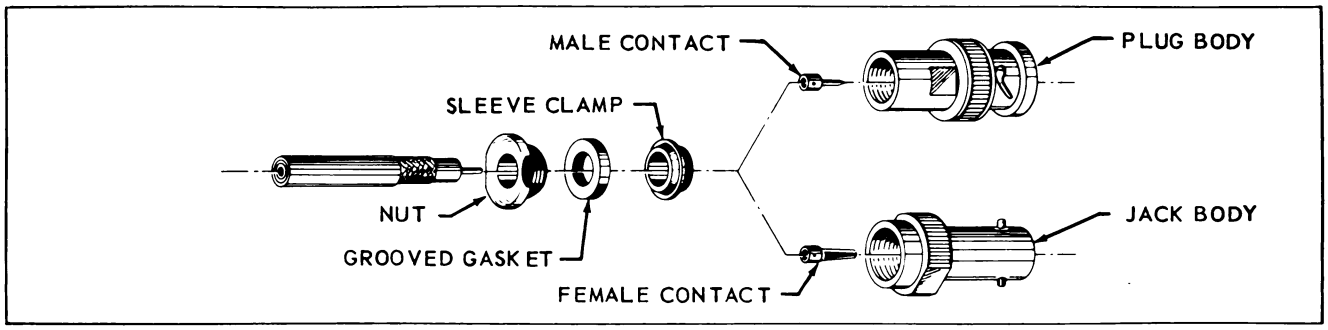


Figure 4–18. Improved BNC Connectors – Exploded View

c. Improved Version (see Figure 4–18) – consists of a plug or jack body assembled to coaxial cable with nut, grooved gasket and sleeve clamp. Plug UG-88C/U and Jack UG-89B/U are typical of this version. This improved version differs from the standard version in the shape of the sleeve clamp. The sleeve clamp has a sharp rear face which cuts into the grooved gasket and thus makes a tight seal.

4–31. ATTACHING STANDARD BNC CONNECTORS TO COAXIAL CABLE. When attaching standard BNC connectors to coaxial cable (see Figure 4–19), follow this procedure:

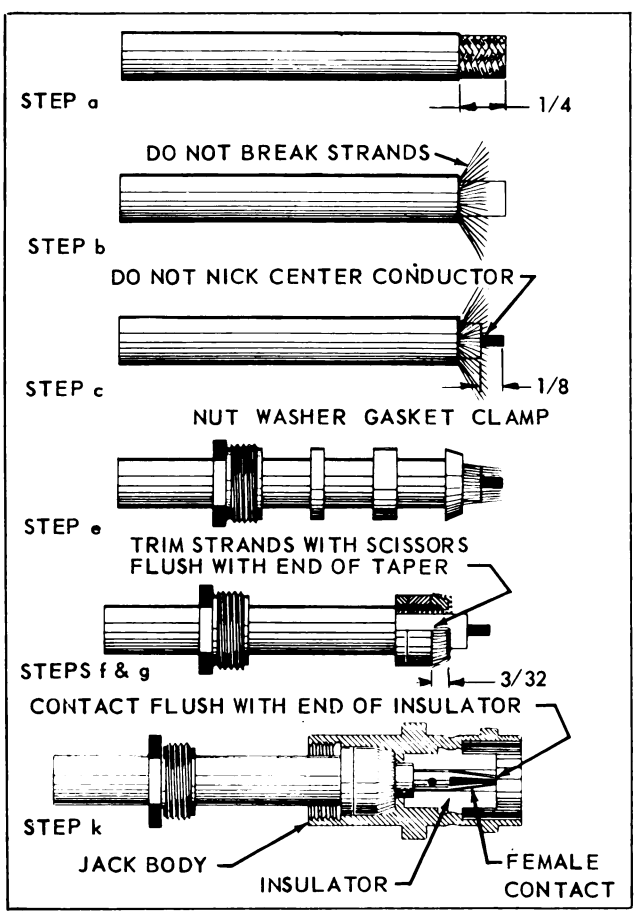


Figure 4–19. Attaching Standard BNC Connectors to Coaxial Cable

NOTE

While attachingconnector, observe all general precautions and procedures listed in paragraphs 4–8 through 4–24.

a. Remove 1/4inch of outer jacket exposing shield. See Figure 4–8.

CAUTION

Do not nick shield.

b. Comb out shield. Use care to prevent breaking shield strands.

c. Strip 1/8 inch of dielectric, exposing center conductor.

CAUTION

Do not nick center conductor.

d. Disassemble nut, washer, gasket and clamp from plug or jack body. See Figure 4–16.

e. Taper shield toward center conductor, and slide nut, washer and gasket, in that order, over tapered shield onto jacket. Then, slide clamp over tapered shield until clamp inside shoulder butts flush against cut end of jacket.

f. Slide gasket and washer forward tight against clamp.

g. Comb shield back smoothly over clamp and trim to 3/32 inch with scissors.

h. Tin center conductor as shown in Figure 4–10.

i. Tin inside of contact (male or female) as shown in Figure 4–11.

j. Slip contact over center conductor so that contact butts flush against dielectric. Solder using a clean, well tinned, soldering iron: contact must still be flush against dielectric after solder has cooled; if it is not, remake the joint. See Figure 4–12.

CAUTION

Be sure that correct contact is being used; a male contact always goes into a plug body, and a female contact always goes into a jack body.

k. Push cable assembly into connector body as far as it will go. Slide nut into connector body and fasten body in vise. Start nut by hand and tighten with end wrench until moderately tight. See Figure 4–13.

4–32. ATTACHING MODIFIED STANDARD BNC CONNECTORS TO COAXIAL CABLE. When attaching modified standard BNC connectors to coaxial cable (see Figure 4–20), follow this procedure:

NOTE

While attaching connector, observe all general precautions and procedures listed in paragraphs 4–8 through 4–24.

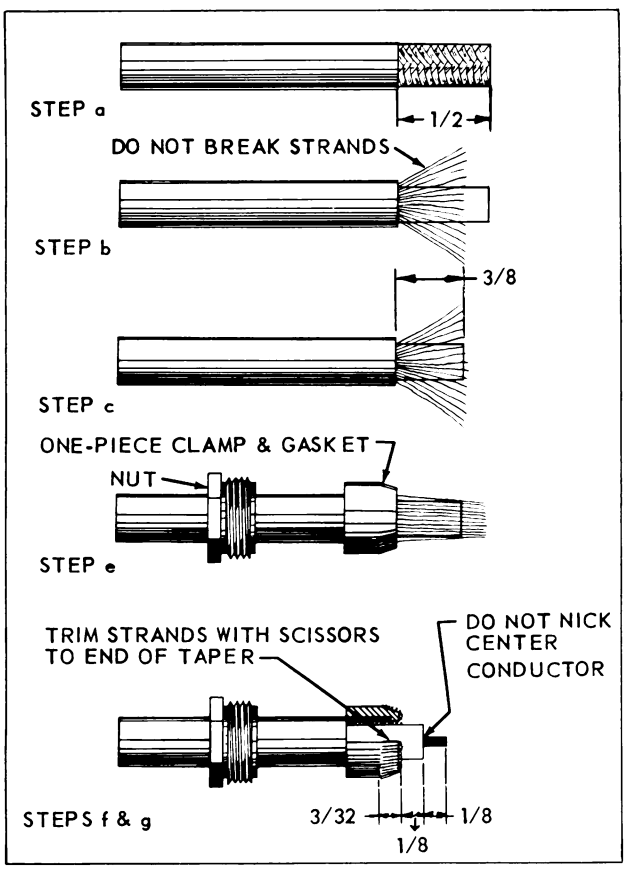


Figure 4–20. Attaching Modified Standard BNC Connectors to Coaxial Cable

a. Strip 1/2 inch of outer jacket exposing shield. See Figure 4–8.

CAUTION

Do not nick shield.

b. Comb out shield. Use care to prevent breaking shield strands.

c. Cut off center conductor and dielectric to 3/8 inch from end of jacket.

d. Disassemble nut and one-piece clamp and gasket from plug or jack body. See Figure 4–17.

e. Taper shield to cover end of cable and slide nut over tapered shield onto jacket. Then, slide one-piece clamp and gasket over tapered shield until clamp inside shoulder butts flush against cut end of jacket.

f. Comb shield back smoothly over one-piece clamp and gasket, and trim to 3/32 inch with scissors.

g. Strip dielectric to 1/8 inch from shield, exposing center conductor. Cut off center conductor 1/8 inch from end of dielectric.

h. Tin center conductor as shown in Figure 4–10.

i. Tin inside of contact (male or female) as shown in Figure 4–11.

j. Slip contact over center conductor so that contact butts flush against dielectric. Solder using a clean, well tinned, soldering iron: contact must still be flush against dielectric after solder has cooled; if it is not, remake the joint. See Figure 4–12.

CAUTION

Be sure that correct contact is being used; a male contact always goes into a plug body, and a female contact always goes into a jack body.

k. Push cable assembly into connector body as far as it will go. Refer to Figure 4–19, step k. Slide nut into connector body and fasten body in vise. Start nut by hand and tighten with end wrench until moderately tight. See Figure 4–13.

4–33. ATTACHING IMPROVED BNC CONNECTORS TO COAXIAL CABLE. When attaching improved BNC connectors to coaxial cable (see Figure 4–21), follow this procedure:

NOTE

While attaching connector, observe all general precautions and procedures listed in paragraphs 4–8 through 4–24.

a. Remove 5/16 inch of outer jacket, exposing shield. See Figure 4–8.

CAUTION

Do not nick shield.

b. Comb out shield. Use care to prevent breaking shield strands.

c. Strip dielectric to 3/16 inch from edge of jacket, exposing center conductor.

CAUTION

Do not nick center conductor.

d. Disassemble nut, grooved gasket and sleeve clamp from plug or jack body. See Figure 4–18.

e. Taper shield toward center conductor, and slide nut and grooved gasket, in that order, over tapered shield onto jacket. Then, slide sleeve clamp over tapered shield until clamp inside shoulder butts flush against cut end of jacket.

f. Comb shield back smoothly over sleeve clamp and trim to 3/32 inch with scissors.

g. Trim dielectric to 1/8 inch from shield, and cut off center conductor to 1/8 inch from edge of dielectric.

h. Tin center conductor as shown in Figure 4–10.

i. Tin inside of contact (male or female) as shown in Figure 4–11.

j. Slip contact over center conductor so that contact butts flush against dielectric. Solder using a clean, well tinned, soldering iron: contact must still be flush against dielectric after solder has cooled; if it is not, remake the joint. See Figure 4–12.

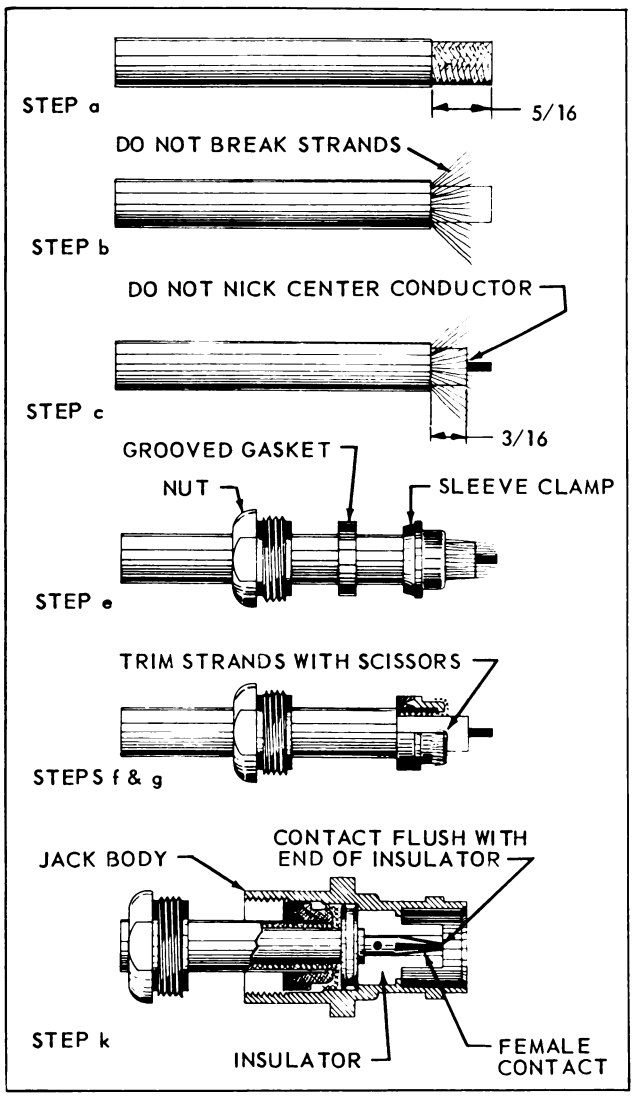


Figure 4–21. Attaching Improved BNC Connectors to Coaxial Cable

CAUTION

Be sure that correct contact is being used; a male contact always goes into a plug body, and a female contact always goes into a jack body.

k. Push cable assembly into connector body as far as it will go, Make sure gasket is properly seated, with sharp edge of sleeve clamp entering gasket groove Slide nut into connector body and fasten in vise. Start nut by hand and tighten with end wrench until enough pressure is applied to make a good seal by splitting the gasket. See Figure 4–13.

4–34. HN SERIES CONNECTORS.

4–35. HN CONNECTOR TYPES. There are two versions of HN connectors. These versions differ in the method of securing coaxial cable to the connector body. See Figure 4–2 for typical examples of HN connectors. Table XXVII lists the more common connectors in the HN series and shows the coaxial cables associated with each.

a. Standard Version (See Figure 4–22) – consists of a plug or jack body assembled to coaxial cable with nut, washer, gasket and clamp. Plug UG-59A/U and Jack UG-60A/U are typical of this version.

b. Air Force Version (See Figure 4–23) – consists of a plug or jack body assembled to coaxial cable with nut, gland, grooved gasket and clamp. Plug UG-59B/U and Jack UG-60B/U are typical of this version. These differ from the standard version in the shape of the gasket. The gland has a sharp face which cuts into the grooved gasket and thus makes a tight seal.

4–36. ATTACHING STANDARD HN CONNECTORS TO COAXIAL CABLE. When attaching standard HN connectors to coaxial cable (see Figure 4–24), follow this procedure:

NOTE

While attaching connector, observe all general precautions and procedures listed in paragraphs 4–8 through 4–24.

a. Disassemble nut, washer, gasket and clamp from plug or jack body. See Figure 4–22.

TABLE XXVII

HN Series Connectors With Associated Cables

Plug	*Jack*	*Panel Jack*	*Cable*
UG-59A/U (*)	UG-60A/U (*)	UG-61A/U (*)	RG-8/U single shield
UG-59B/U (**)	UG-60B/U (**)	UG-61B/U (**)	RG-9/U double shield
UG-494/U (*)			RG-14/U double shield
UG-495A/U (*)	UG-333/U (*)	UG-334/U (*)	RG-17A/U single shield
	UG-333A/U (*)	UG-334A/U (*)	RG-17B/U double shield

(*) Standard Version; (**) Air Force Version

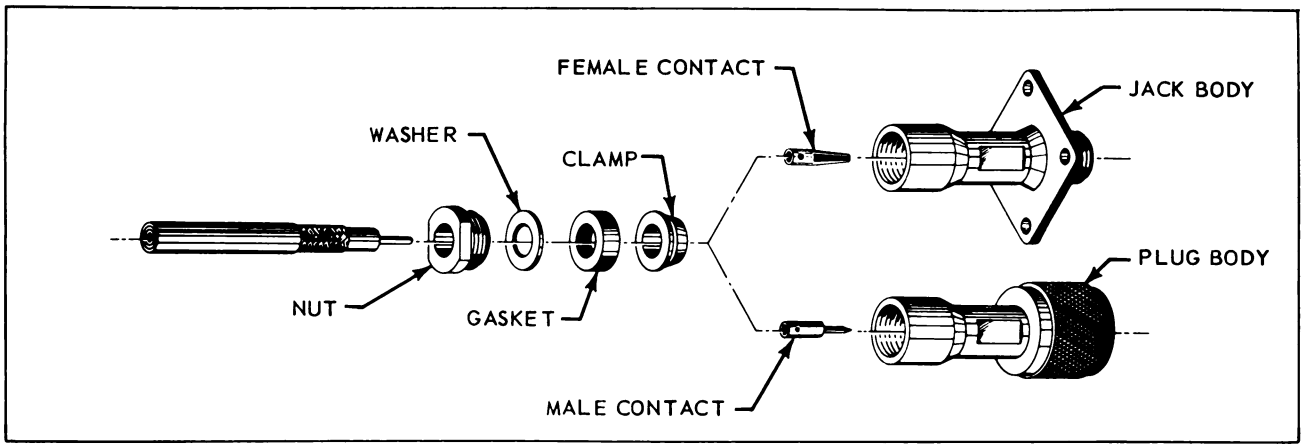


Figure 4–22. Standard HN Connectors – Exploded View

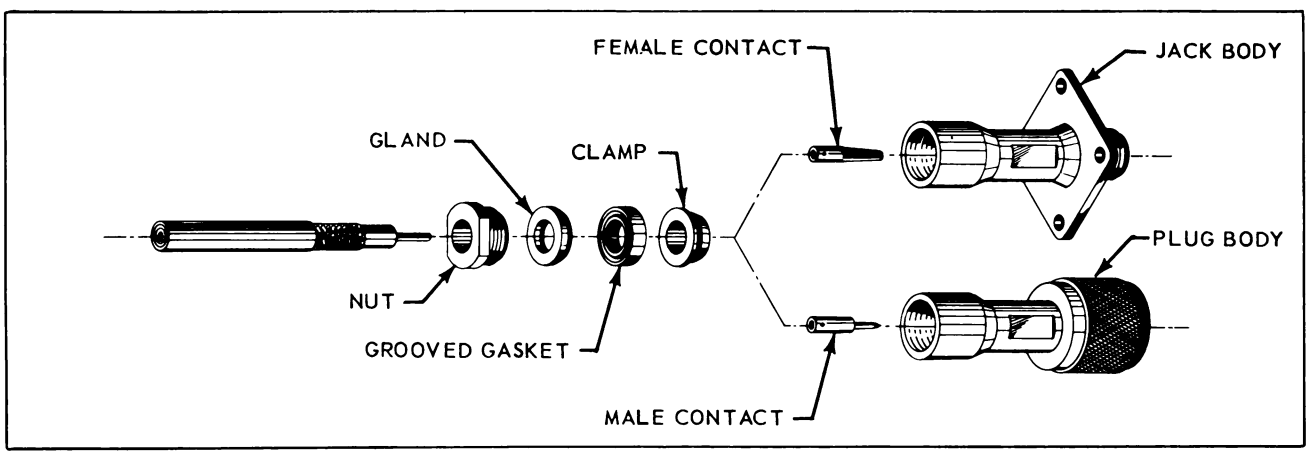


Figure 4–23. Air Force Version HN Connectors – Exploded View

b. Slide nut, washer and gasket, in that order, onto cable jacket.

c. Remove 1-1/8 inches of outer jacket, exposing shield. See Figure 4–8.

CAUTION

Do not nick shield.

d. Slide clamp over shield until clamp inside shoulder butts flush against cut end of jacket.

e. Comb out shield, and trim strands with scissors to approximately 1/4 inch from clamp. Use care to prevent nicking dielectric.

f. Fold strands back over clamp without overlaps. Retrim strands with scissors, so that all strands end at end of clamp taper.

g. Strip dielectric to 3/4 inch from fold of shield.

CAUTION

Do not nick center conductor.

h. Cut center conductor to 1/4 inch from end of dielectric.

i. Tin center conductor as shown in Figure 4–10.

j. Tin inside of contact (male or female) as shown in Figure 4–11.

k. Slip contact over center conductor so that contact butts flush against dielectric. Solder using a clean, well tinned, soldering iron: contact must still be flush against dielectric after solder has cooled; if it is not, remake the joint. See Figure 4–12.

CAUTION

Be sure that correct contact is being used; a male contact always goes into a plug body, and a female contact always goes into a jack body.

l. Taper dielectric using Tapering Tool MX-103/U. Use tool like a pencil sharpener. See Figure 4–25.

NOTE

For jacks (female contacts) set tool stop at top of slot. Stop cutting when contact reaches end of tool. For plugs (male contacts) set tool stop at bottom of slot. Tool will stop cutting when taper is complete.

m. Wipe small amount of MIL-I-8660 insulating and sealing compound on tapered surface of dielectric and push cable assembly into connector body as far as it will go. Slide washer and gasket into connector body.

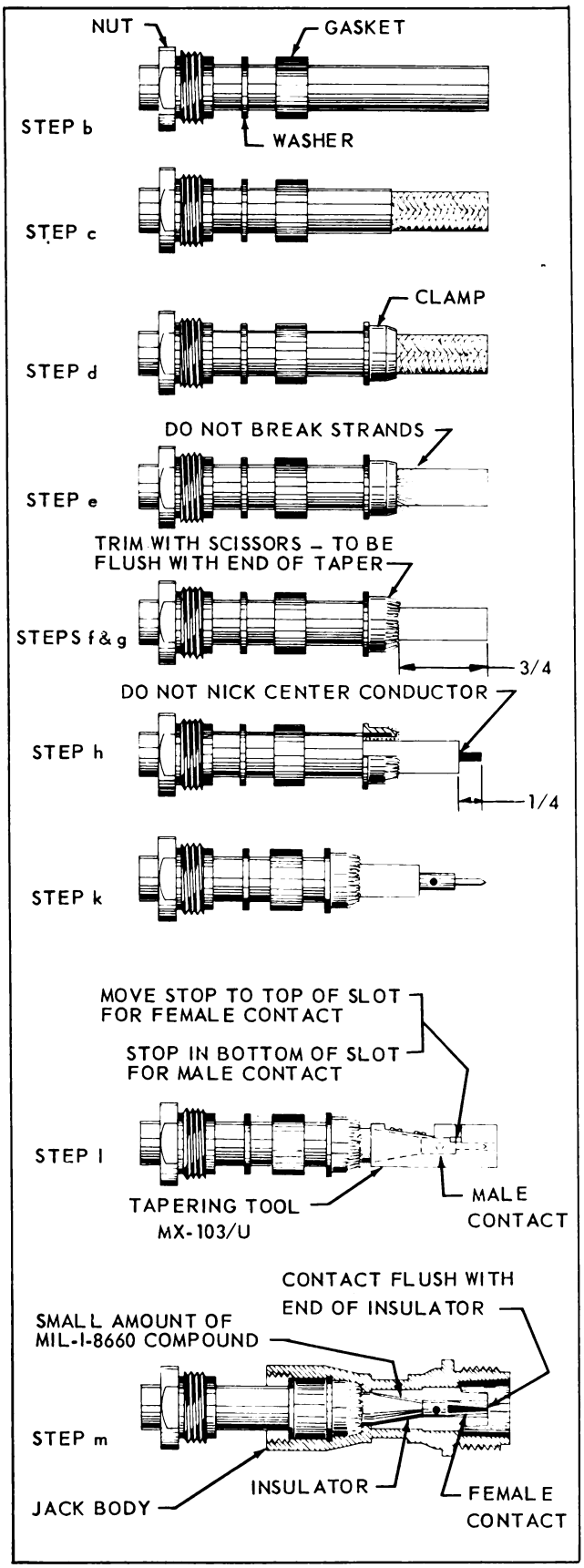


Figure 4–24. Attaching Standard HN Connectors to Coaxial Cable

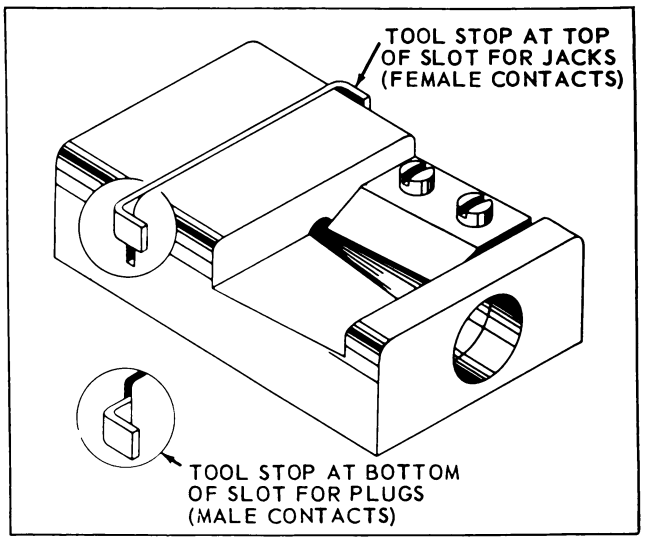


Figure 4–25. Tapering Tool MX-103/U

Make sure that gasket is fully seated and not caught by the threaded portion of the body. Then, slide nut into connector body and fasten body in vise. See Figure 4–13. Start nut by hand and tighten with end wrench until moderately tight.

4–37. ATTACHING AIR FORCE HN CONNECTORS TO COAXIAL CABLE. When attaching Air Force HN connectors to coaxial cable (see Figure 4–26), follow this procedure:

NOTE

While attaching connector, observe all general precautions and procedures listed in paragraphs 4–8 through 4–24.

a. Disassemble nut, gland, grooved gasket and clamp from plug or jack body. See Figure 4–23.

b. Remove 1-1/8 inches from outer jacket, exposing shield. See Figure 4–8.

CAUTION

Do not nick shield.

c. Comb out shield and strip dielectric 1/4 inch.

CAUTION

Do not nick center conductor.

d. Slide nut, gland and grooved gasket, in that order, onto jacket. Make sure that sharp edge of gland is toward gasket, and that groove in gasket faces gland.

e. Slide clamp over shield until clamp inside shoulder butts flush against cut end of jacket.

f. Fold shield strands back over clamp without overlaps. Trim strands with scissors, so that all strands end at end of clamp taper.

g. Tin center conductor as shown in Figure 4–10.

h. Tin inside of contact (male or female) as shown in Figure 4–11.

i. Slip contact over center conductor so that contact butts flush against dielectric. Solder using a

clean, well tinned, soldering iron: contact must still be flush against dielectric after solder has cooled; if it is not, remake the joint. See Figure 4–12.

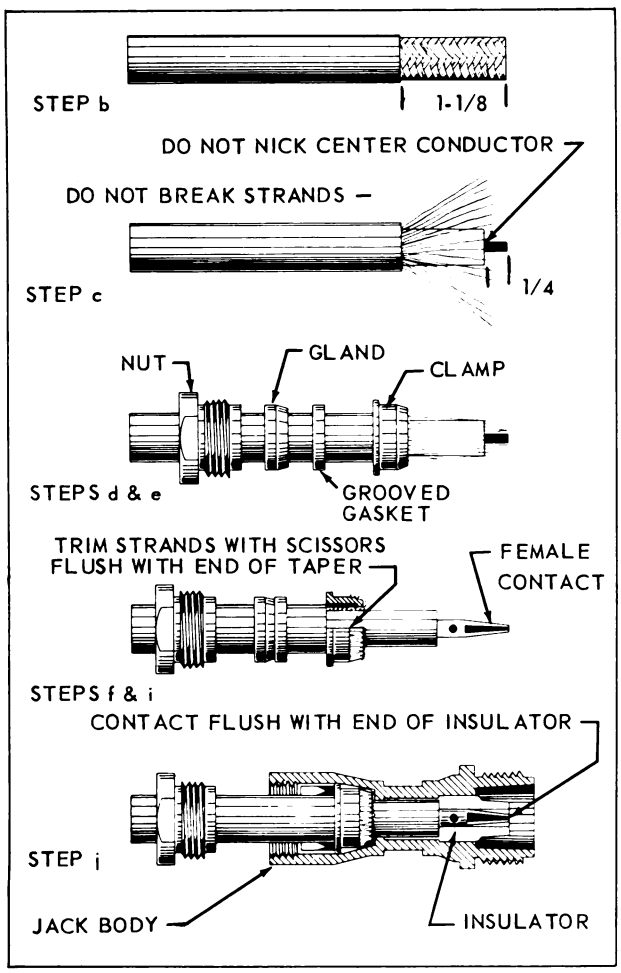


Figure 4–26. Attaching Air Force Version HN Connectors to Coaxial Cable

CAUTION

Be sure that correct contact is being used; a male contact always goes into a plug body, and a female contact always goes into a jack body.

j. Push cable assembly into connector body as far as it will go. Slide gasket and gland into connector body. Be sure knife edge of gland remains in groove of gasket. Then, slide nut into connector body and fasten body in vise. See Figure 4–13. Start nut by hand and tighten with end wrench until moderately tight.

NOTE

Gasket should be cut in half during tightening.

4–38. N SERIES CONNECTORS.

4–39. N CONNECTOR TYPES. There are three versions of N connectors. These versions differ in the method of securing coaxial cable to the connector body. See Figure 4–3 for typical examples of N connectors. Table XXVIII lists the more common connectors in the N series and shows the coaxial cables associated with each.

a. Standard Version (See Figure 4–27) – consists of a plug or jack body assembled to coaxial cable with nut, washer, gasket and clamp. Plug UG-18B/U and Jack UG-20B/U are typical of this version.

b. Air Force Version (See Figure 4–28) – consists of a body assembled to coaxial cable with nut, gland, grooved gasket and clamp. Plug UG-21C/U and Jack UG-23C/U are typical of this version. These differ from the standard version in the shape of the grooved gasket. The gland has a sharp face which cuts into the grooved gasket and thus makes a tight seal.

c. Improved Version (See Figure 4–29) – consists of a body assembled to coaxial cable with nut, grooved

TABLE XXVIII

N Series Connectors With Associated Cables

Plug	*Jack*	*Panel Jack*	*Cable*	
UG-18A/U (*)	UG-20A/U (*)	UG-19A/U (*)	RG-5/U	double shield
UG-18B/U (*)	UG-20B/U (*)	UG-19B/U (*)	RG-6/U	double shield
UG-18C/U (***)	UG-20C/U (***)	UG-19C/U (***)	RG-21/U	double shield
		UG-22A/U (*)		
UG-21A/U (*)	UG-23A/U (*)	UG-22B/U (*)		
UG-21B/U (*)	UG-23B/U (*)	UG-22C/U (**)	RG-8/U	single shield
UG-21C/U (**)	UG-23C/U (**)	UG-22D/U (***)	RG-9/U	double shield
UG-21D/U (***)	UG-23D/U (***)	UG-160A/U (*)		
		UG-160B/U (**)		
UG-204A/U (*)				
UG-204B/U (***)			RG-14/U	double shield
UG-167A/U (*)			RG-17A/U	single shield
UG-167C/U (***)			RG-17B/U	double shield

(*) Standard Version; (**) Air Force Version; (***) Improved Version

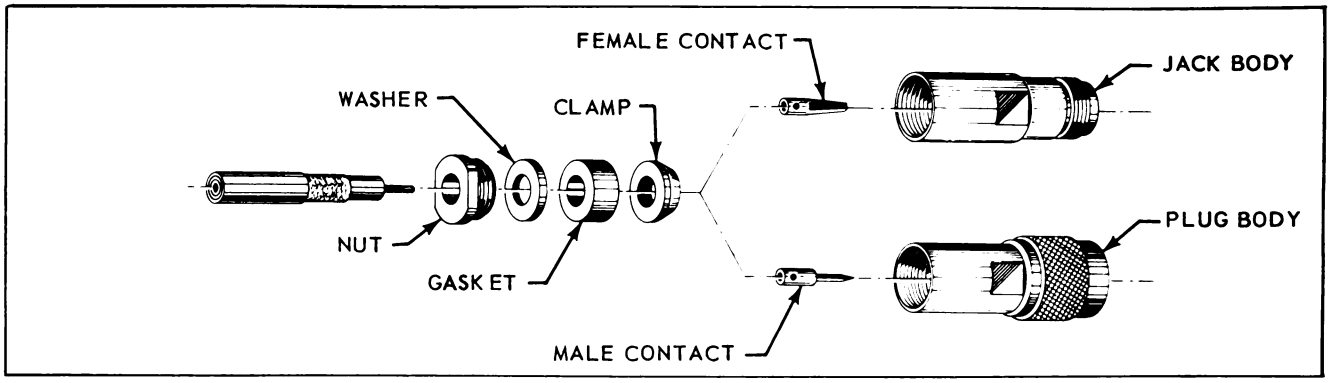


Figure 4–27. Standard N Connectors – Exploded View

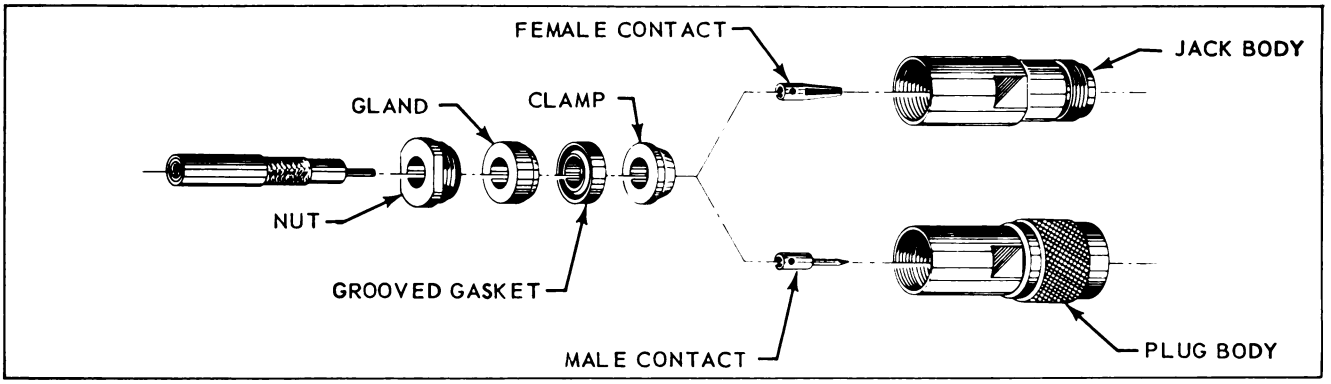


Figure 4–28. Air Force Version N Connectors – Exploded View

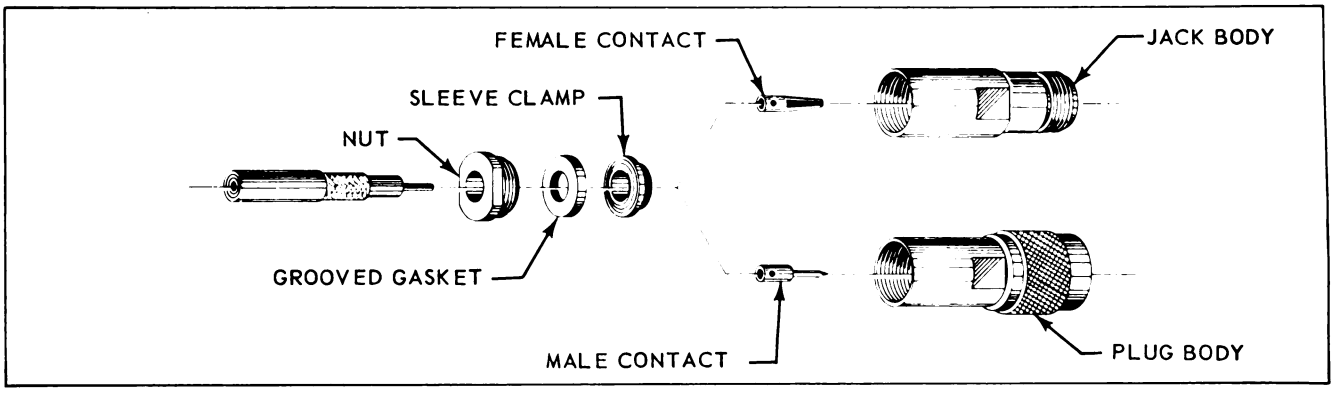


Figure 4–29. Improved N Connectors – Exploded View

gasket and clamp. Plug UG-18C/U and Jack UG-20C/U are typical of this version. These differ from the Air Force version in the use of a sleeve clamp which has a sharp rear face. The grooved gasket faces this and is cut when the nut is tightened.

4–40. ATTACHING STANDARD N CONNECTORS TO COAXIAL CABLE. When attaching standard N connectors to coaxial cable (see Figure 4–30), follow this procedure:

NOTE

While attaching connector, observe all general precautions and procedures listed in paragraphs 4–8 through 4–24.

a. Remove 1/2 inch of outer jacket, exposing shield. See Figure 4–8.

CAUTION

Do not nick shield.

b. Comb out shield, and strip 1/4 inch of dielectric, exposing center conductor.

CAUTION

Do not nick center conductor.

c. Disassemble nut, washer, gasket and clamp from plug or jack body. See Figure 4–27.

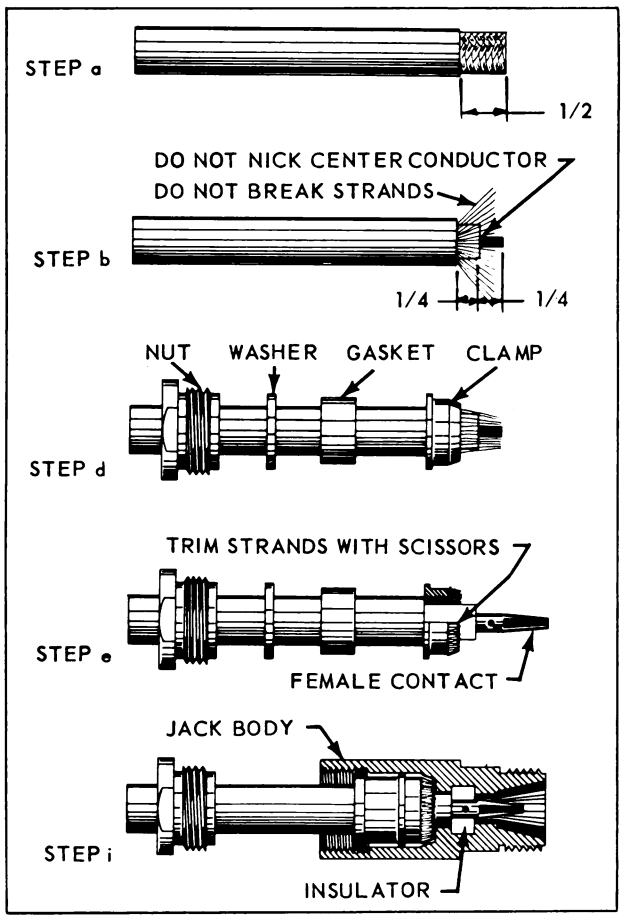


Figure 4–30. Attaching Standard N Connectors to Coaxial Cable

d. Taper shield toward center conductor, and slide nut, washer and gasket, in that order, over tapered shield onto jacket. Then, slide clamp over tapered shield until clamp inside shoulder butts flush against cut end of jacket.

e. Fold shield strands back over clamp taper without overlaps. Trim shield with scissors, so that strands end at end of clamp taper.

f. Tin center conductor as shown in Figure 4–10.

g. Tin inside of contact (male or female) as shown in Figure 4–11.

h. Slip contact over center conductor so that contact butts flush against dielectric. Solder using a clean, well tinned, soldering iron: contact must still be flush against dielectric after solder has cooled; if it is not, remake the joint. See Figure 4–12.

CAUTION

Be sure that correct contact is being used; a male contact always goes into a plug body, and a female contact always goes into a jack body.

i. Push cable assembly into connector body as far as it will go. Slide gasket and washer into connector body. Then, slide nut into connector body and fasten body in vise. See Figure 4–13. Start nut by hand and tighten with end wrench until moderately tight.

4–41. ATTACHING AIR FORCE N CONNECTORS TO COAXIAL CABLE. When attaching Air Force N connectors at coaxial cable, follow the procedure described in paragraph 4–40 and in Figure 4–30. The stripping dimensions and the assembly sequences are exactly the same as those for Standard N connectors, except that a gland and grooved gasket replace the washer and gasket. See Figure 4–28.

4–42. ATTACHING IMPROVED N CONNECTORS TO COAXIAL CABLE. When attaching improved N connectors to coaxial cable (see Figure 4–31), follow this procedure:

NOTE

While attaching connector, observe all general precautions and procedures listed in paragraphs 4–8 through 4–24.

a. Remove 9/32 inch of outer jacket, exposing shield. See Figure 4–8.

CAUTION

Do not nick shield.

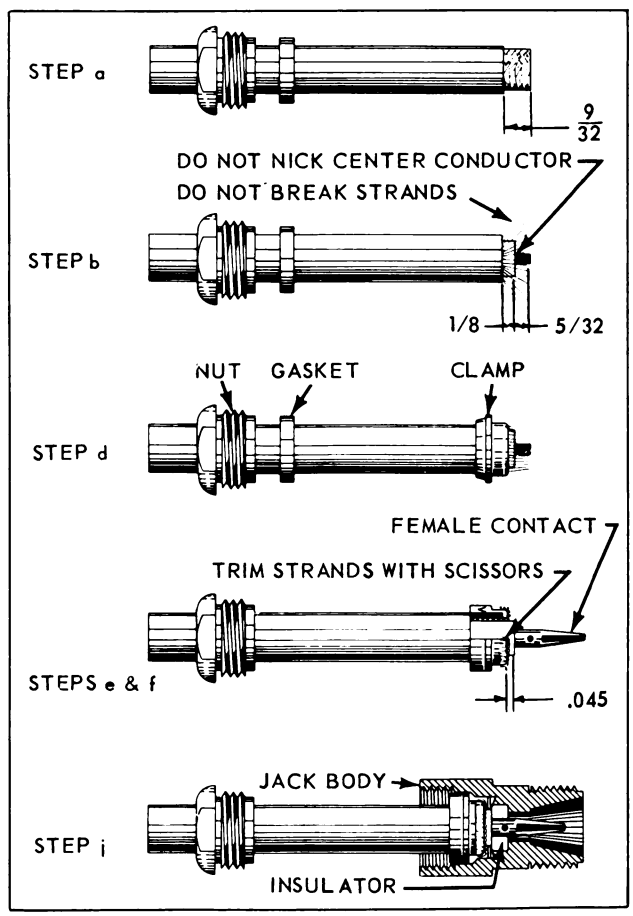


Figure 4–31. Attaching Improved N Connectors to Coaxial Cable

b. Comb out shield and strip dielectric to 1/8 inch om end of jacket, exposing 5/32 inch of center conuctor.

CAUTION

Do not nick center conductor.

c. Disassemble nut, gasket and sleeve clamp from lug or jack body. See Figure 4–29.

d. Taper shield toward center conductor, and slide ut and gasket, in that order, over tapered shield onto acket. Make sure grooved side of gasket faces away om nut. Then, slide sleeve clamp over tapered hield until clamp inside shoulder butts flush against ut end of jacket.

e. Fold shield strands back over sleeve clamp aper without overlaps. Trim shield with scissors, so at strands end at end of clamp taper.

f. Check that exposed dielectric is .045 inch beond shield.

g. Tin center conductor as shown in Figure 4–10.

h. Tin inside of contact (male or female) as shown n Figure 4–11.

i. Slip contact over center conductor so that conact butts flush against dielectric. Solder using a lean, well tinned soldering iron: contact must still be flush against dielectric after solder has cooled; if it is not, remake the joint. See Figure 4–12.

CAUTION

Be sure that correct contact is being used; a male contact always goes into a plug body, and a female contact always goes into a jack body.

j. Push cable assembly into connector body as far as it will go. Slide gasket into connector body. Be sure knife edge of sleeve clamp seats into groove of gasket. Then, slide nut into connector body and fasten body in vise. See Figure 4–13. Start nut by hand, tighten with end wrench until moderately tight. Gasket should be cut in half during tightening.

4–43. C SERIES CONNECTORS.

4–44. C CONNECTORS. (See Figure 4–4.) There is only one version of C connector. It consists of a body assembled to coaxial cable by means of a nut, gasket and sleeve clamp. Table XXIX lists the more common connectors in the C series and shows the coaxial cables associated with each. Plug UG-573A/U and Jack UG-572/U are typical C connectors. See Figure 4–32.

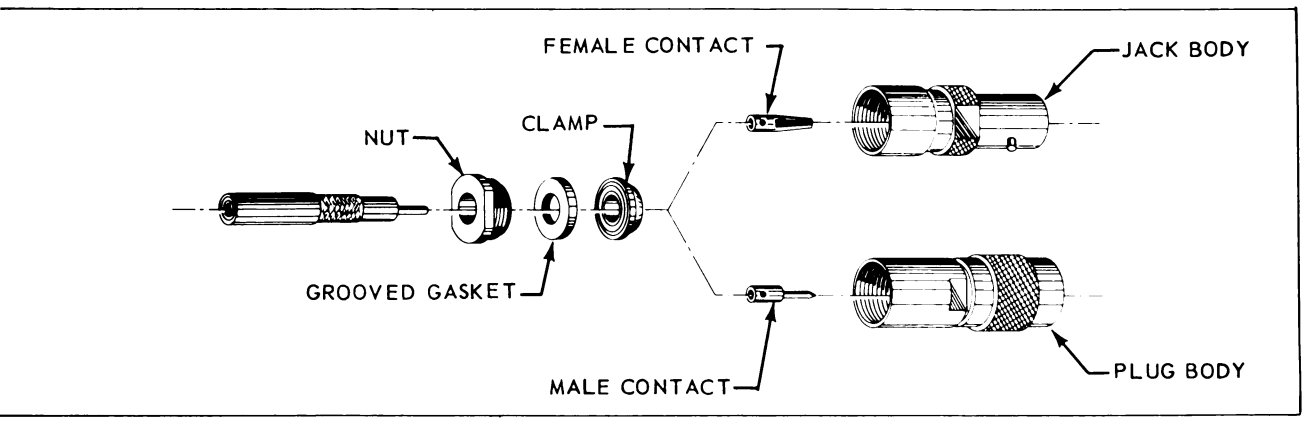


Figure 4–32. C Connectors – Exploded View

TABLE XXIX

C Series Connectors With Associated Cables

Plug	*Jack*	*Panel Jack*	*Cable*
UG-628A/U	UG-572/U	UG-570/U UG-632/U UG-571/U	RG-8/U single shield RG-9/U double shield
UG-707/U UG-707A/U			RG-14/U double shield
UG-708/U			RG-17A/U single shield RG-17B/U double shield
UG-626/U	UG-633/U	UG-629/U UG-630/U	RG-5/U double shield RG-6/U double shield RG-21/U double shield
UG-709A/U		UG-704/U	RG-55/U double shield RG-58/U single shield

4-45. ATTACHING C CONNECTORS TO COAXIAL CABLE. When attaching C connectors to coaxial cable (see Figure 4-33), follow this procedure:

NOTE

While attaching connector, observe all general precautions and procedures listed in paragraphs 4-8 through 4-24.

a. Disassemble nut, gasket and sleeve clamp from plug or jack body. See Figure 4-32.

b. Slide nut and gasket, in that order, onto jacket. Make sure grooved face of gasket is away from nut.

c. Strip outer jacket to "A" dimension given in Table XXX, exposing shield. See Figure 4-8.

CAUTION

Do not nick shield.

d. Comb out shield and strip dielectric to "B" dimension given in Table V.

CAUTION

Do not nick center conductor.

e. Taper shield toward center conductor and slide sleeve clamp over tapered shield until clamp inside shoulder butts flush against cut end of jacket.

f. Fold shield strands back over sleeve clamp taper without overlaps. Trim shield with scissors so that strands end at end of clamp taper.

g. Check that dielectric is exposed exactly to "C" dimension in Table XXX.

CAUTION

"C" dimension is critical, and must be held to dimension given within a tolerance of ± .005 inch.

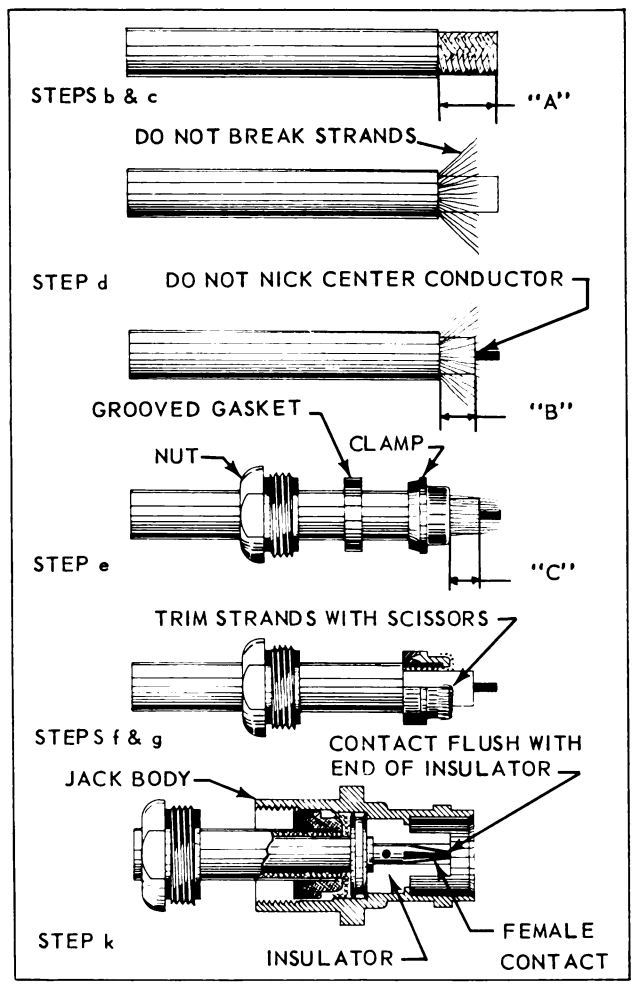


Figure 4-33. Attaching C Connectors to Coaxial Cable

TABLE XXX

Assembly Dimensions For C Series Connectors

Connectors	*Cables*	*Dimensions** A	B	C
UG-626/U plug UG-629/U jack UG-630/U jack UG-633/U jack	RG-5/U RG-6/U RG-21/U	9/32	1/8	.045
UG-570/U jack UG-571/U jack UG-572/U jack UG-573/U plug	RG-8/U RG-9/U	9/32	1/8	.045
UG-628/U plug UG-632/U jack	RG-8/U RG-9/U	19/32	7/16	.332
UG-707/U plug	RG-14/U	11/32	3/16	.065
UG-708/U plug	RG-17A/U	11/32	3/16	.065
UG-704/U jack	RG-55/U RG-58/U	3/8	7/32	15/64
UG-799/U plug	RG-55/U RG-58/U	3/8	7/32	5/32

*Tolerances: Fractions, ± 1/64"; Decimals, ± .005"

h. Tin center conductor as shown in Figure 4–10.

i. Tin inside of contact (male or female) as shown in Figure 4–11.

j. Slip contact over center conductor so that contact butts flush against dielectric. Solder using a clean, well tinned soldering iron: contact must still be flush against dielectric after solder has cooled; it it is not, remake the joint. See Figure 4–12.

CAUTION

Be sure that correct contact is being used; a male contact always goes into a plug body, and a female contact always goes into a jack body.

k. Push cable assembly into connector body as far as it will go. Slide gasket into connector body. Make sure gasket is properly seated, with sharp edge of sleeve clamp entering groove in gasket. Then, slide nut into connector body and fasten body in vise. See Figure 4–13. Start nut by hand and tighten with end wrench until moderately tight. Gasket should be cut in half during tightening.

4–46. PULSE SERIES CONNECTORS.

4–47. PULSE CONNECTOR TYPES. There are two versions of pulse connectors. These versions differ in the material of the inserts, and in the method of securing the coaxial cable to the connector body. See Figure 4–5 for typical examples of pulse connectors. Table XXXI lists the more common connectors in the pulse series and shows the coaxial cables associated with each.

a. Ceramic Insert Version (See Figure 4–34) – consists of a plug or jack body assembled to coaxial cable with nut, cable clamp, washer and corona shield. Plug UG-174/U is typical of this version.

b. Rubber Insert Version (see Figure 4–35) – consists of a plug or jack body assembled to coaxial cable with clamp, washer, sleeve, gasket and ferrule. Plug UG-180A/U and Jack UG-182A/U are typical of this version.

4–48. ATTACHING CERAMIC INSERT PULSE CONNECTORS TO COAXIAL CABLE.

NOTE

The following procedure is for assembling UG-174/U plug to RG-28/U cable, and UG-34/U plug to RG-25/U cable. The two assemblies differ in dimensions as indicated in the procedure steps. Both cables have a double shield.

When attaching ceramic insert pulse connectors to coaxial cable (see Figure 4–36) follow this procedure:

NOTE

While attaching connector, observe all general precautions and procedures listed in paragraphs 4–8 through 4–24.

a. Disassemble nut, cable clamp, washer and corona shield from plug or jack body. See Figure 4-34.

b. Slide nut and cable clamp in that order onto cable jacket. Remove 3-5/8 inches of outer jacket of RG-28/U cable and 2-3/4 inches of RG-25/U cable exposing first shield, (see note at beginning of paragraph). See Figure 4–8.

CAUTION

Do not nick shield.

c. Remove first shield to 5/16 inch from cut edge of outer jacket exposing insulating tape.

d. Comb out shield and bend at right angles, as shown. Remove insulating tape even with cut edge of outer jacket, exposing second shield.

CAUTION

Do not nick shield.

Slide cable clamp forward against fanned-out first shield. Trim shield strands 1/16 inch below diameter of cable clamp flange.

e. Slide brass washer carefully over second shield against fanned-out shield. Remove second shield to 3/16 inch from brass washer for RG-28/U cable, and 1/8 inch for RG-25/U cable, exposing conducting rubber.

TABLE XXXI

Pulse Series Connectors With Cables

Plug	*Jack*	*Panel Jack*	*Cable*
Ceramic Insert			
UG-34A/U			RG-25/U double shield RG-25A/U double shield
UG-174/U		UG-166/U	RG-28/U double shield
Rubber Insert			
UG-180A/U	UG-182A/U	UG-181A/U	RG-25/U double shield RG-25A/U double shield RG-64/U double shield RG-64A/U double shield RG-78/U single shield

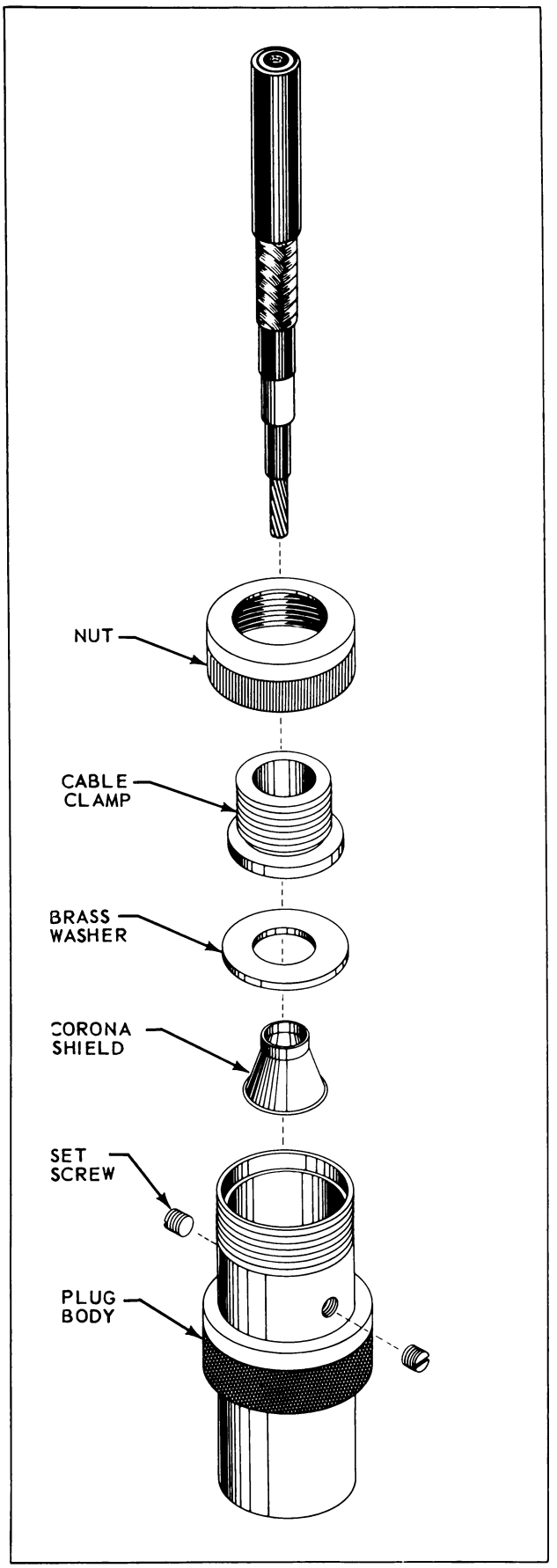


Figure 4–34. Pulse Connector – Ceramic

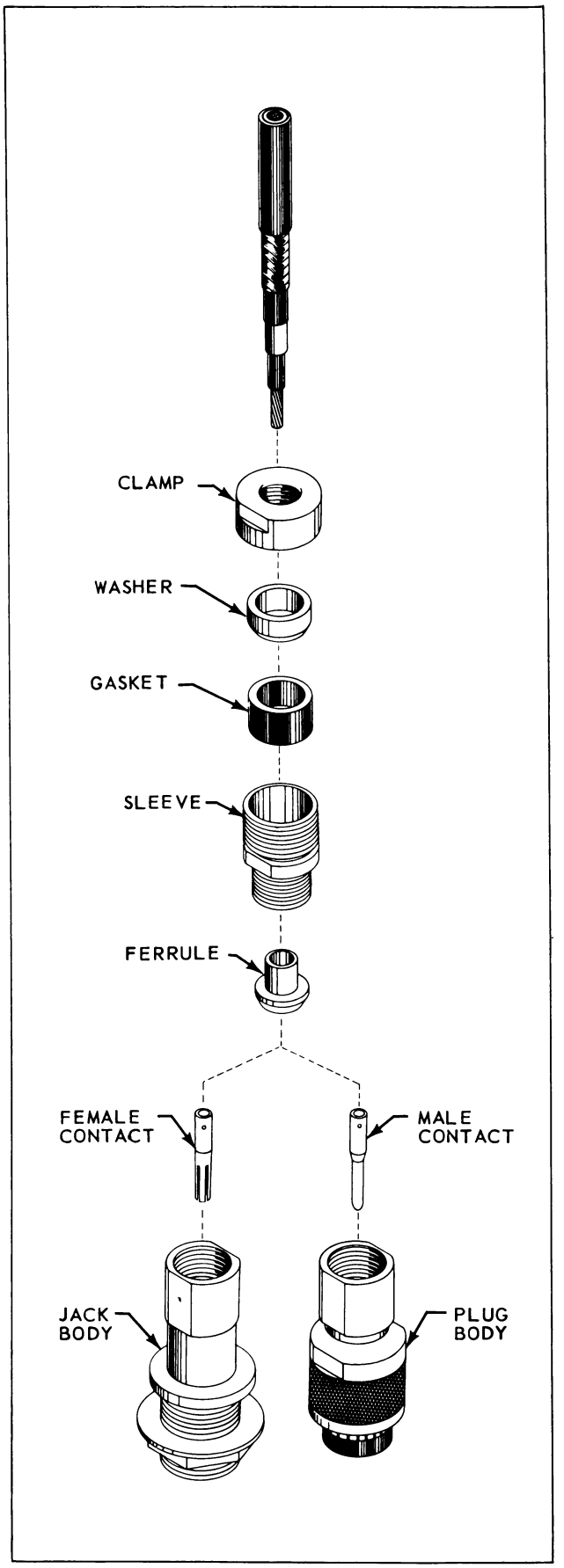


Figure 4–35. Pulse Connector – Rubber

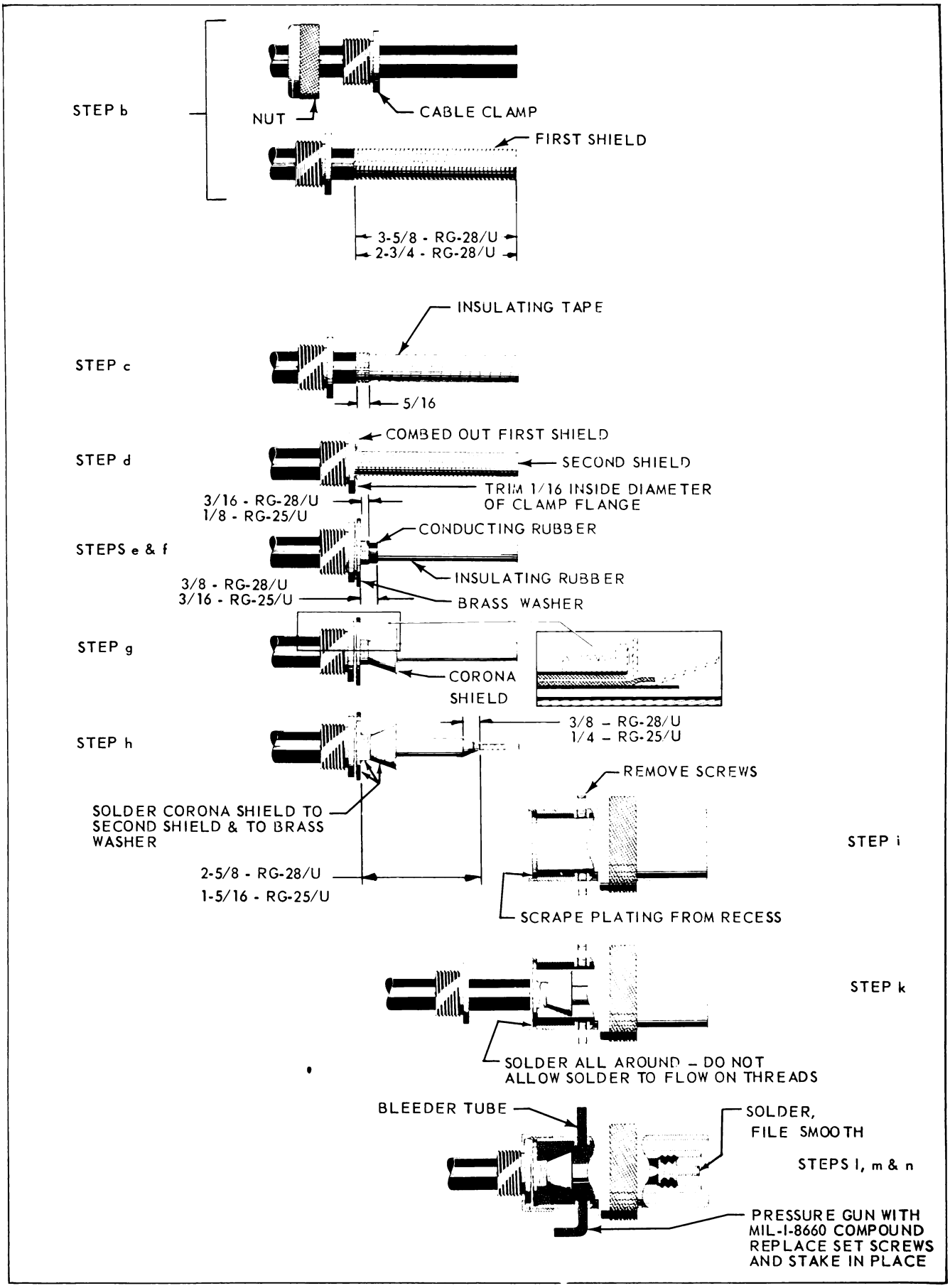


Figure 4–36. Assembly of Ceramic Insert Pulse Connector

f. Remove layer of conducting rubber to 3/8 inch from face of brass washer for RG-28/U cable and 3/16 inch for RG-25/U cable by making small slit at end of cable core, and removing conducting rubber with dull knife. Scrape insulating rubber underneath to remove any traces of conducting rubber.

CAUTION

Do not damage insulating rubber.

g. Slide corona shield over conducting rubber and under second shield until straight part of corona shield enters hole in brass washer approximately 1/16 inch.

h. Solder second shield to brass washer and to corona shield. Remove excess flux. Remove insulating rubber and conducting rubber underneath it to 2-5/8 inches from face of brass washer, for RG-28/U cable, and 1-1/16 inches for RG-25/U cable exposing center conductor. Taper rubber down to conductor 3/8 inch for RG-28/U or 1/4 inch for RG-25/U. Tin center conductor. Remove excess flux.

j. Scrape nickel plating from recess of plug into which brass washer fits. Remove set screws.

k. Slide cable assembly into plug body, allowing cable clamp to slide back on cable. Solder brass washer to recess in plug by flowing solder into space between washer and groove. Remove excess flux.

l. Slide cable clamp against washer, and nut onto plug body. Start nut by hand and tighten with spanner wrench. Hold plug with strap wrench to prevent it from turning.

m. Cut off excess conductor protruding beyond contact pin. Solder conductor to contact by flowing solder down into hole. Leave drop of solder on end of contact and file smooth. Remove excess flux.

n. Insert bleeder tube in top hole, so it is vertical. Insert pressure gun in lower hole and fill plug cavity with MIL-I-8660 compound until material oozes from bleeder tube. Replace set screws and stake with prick punch.

4–49. ATTACHING RUBBER INSERT PULSE CONNECTORS TO COAXIAL CABLE. When attaching rubber insert pulse connectors to coaxial cable (see Figure 4–37) follow this procedure:

NOTE

While attaching connector, observe all general precautions and procedures listed in paragraphs 4–8 through 4–24.

a. Disassemble nut, washer, gasket, sleeve and ferrule from plug or jack body. See Figure 4–35.

b. Slide nut, washer, gasket, and sleeve in that order onto cable jacket. Remove 2-5/8 inches of outer jacket exposing shield. See Figure 4–8.

CAUTION

Do not nick shield.

c. Cut shield(s) to 3/8 inch from cut edge of outer jacket, exposing cable core.

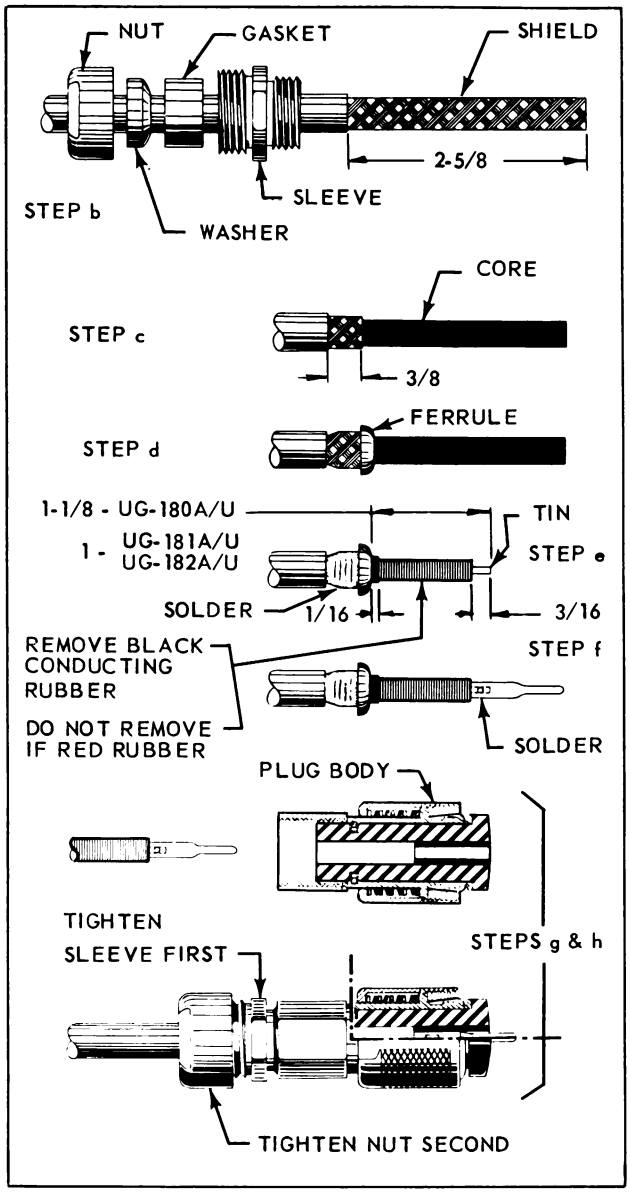


Figure 4–37. Assembly of Rubber Insert Pulse Connector

CAUTION

Do not nick or cut cable core.

d. Push ferrule over cable core and under shield(s).

e. Solder shield(s) carefully to ferrule all around its circumference. Be sure solder flows through to all shields. If it is necessary to solder shields separately, fold back outer shield. Solder inner shield, then bring forward outer shield and solder separately on top of inner shield. After solder has cooled, grasp cable in left hand, ferrule in right hand, and give several quick pulls to remove any slack in shield(s). Remove excess flux. Remove cable core with sharp square cut, leaving 1-1/8 inch from ferrule for connection to UG-181A or 182A/U. Trim center conductor to 3/16 inch and tin.

NOTE

Cables RG-25A/U, RG-64A/U and RG-78/U have a thin layer of *red* insulating rubber over the cable core. Do not remove this layer. Cables RG-25/U and RG-64/U have a thin layer of *black* conducting rubber over the cable core. Remove this layer to 1/16 inch from ferrule very carefully with a sharp knife.

CAUTION

Do not nick or cut cable core.

f. Tin inside of contact (male or female) as shown in Figure 4–11. Slip contact over center conductor so that contact butts flush against cable core. Solder using a clean, well tinned soldering iron; contact must still be flush against cable core after solder has cooled; if it is not, remake the joint. See Figure 4–12. Remove excess flux.

CAUTION

Be sure that correct contact is being used; a male contact always goes into a plug body, and a female contact always goes into a jack body.

g. Push cable core into plug or jack body as far as it will go. Insert sleeve and tighten as far as it will go against ferrule, holding body with wrench so it will not turn.

h. Insert gasket, then washer into sleeve. Install nut on sleeve and tighten until gasket deforms around cable to hold it securely.

SECTION V
SOLDERLESS TERMINATIONS & SPLICINGS

5–1. INTRODUCTION.

5–2. SCOPE. This section describes recommended methods for terminating copper and aluminum wires, using solderless terminal lugs. It also describes recommended methods for permanently joining, better known as "splicing", copper wires, using solderless splices. (Termination of thermocouple wires is covered in Section VI.)

5–3. PURPOSE. Electric wires are terminated with solderless terminal lugs to permit easy and efficient connection to and disconnection from terminal blocks, busbars, and other electrical equipment. Solderless splices join electric wires to form permanent continuous runs.

5–4. GENERAL. Solderless terminal lugs and splices are made of copper or aluminum and are pre-insulated or uninsulated depending on the application.

NOTE

Use copper terminations only on copper wire. Use aluminum terminations only on aluminum wire.

Terminal lugs are available in three types: straight, right-angle and flag, for use under different space conditions. Figure 5–1 shows typical terminal lugs and splices and cutaway views of the completed junctions. Typical crimping tools are illustrated where they are mentioned in the procedures. Terminal lugs and splices are "crimped" (sometimes called "staked" or "swaged") to the wires by means of hand or power crimping tools. Power tools are portable or stationary (bench-mounted). Solderless terminal lugs and splices most commonly used are made by AMP (Aircraft Marine Products), Burndy, and T & B (Thomas and Betts); this section is therefore limited to these items.

5–5. REFERENCE SPECIFICATIONS, DRAWINGS & OTHER DOCUMENTS.

MIL-I-631	Insulation, Electrical, Synthetic-Resin Composition, Nonrigid
MIL-T-5042	Terminals; Electrical, Crimp-Type, Copper
MIL-W-5088	Wiring, Aircraft, Installation of
MIL-T-7099	Terminals; Lug, Crimp Style, for Aluminum Aircraft Cable
MIL-I-7444	Insulation Sleeving, Electrical, Flexible
MIL-T-7928	Terminals; Lug, Crimp Style, Copper, Insulated
AN659	Terminal; Electrical, Crimp Style, Copper
AN3427	Crimping Tool – Electric Cable Terminal, Hand
AND10460	Indentors & Nests – Copper Electric Terminal Power Operated Press
MS25020	Crimping Tool – Hand, for Aluminum Aircraft Cable Terminals
MS25021	Terminal; Lug, Crimp Style, Straight Type; for Aluminum Aircraft Cable
MS25022	Terminal-Lug, Crimp Style, Flag Type; for Aluminum Aircraft Cable
MS25036	Terminal; Lug, Crimp Style, Copper, Insulated
MS25037	Crimping Tool – Hand, for Copper Insulated Terminal
EMB#14-55	Aircraft Electrical Aluminum Wire & Terminals, Installation Practices for (BuAer EL-522)

5–6. TERMINATING SMALL COPPER WIRES (SIZES #22 THROUGH 10).

5–7. PRE-INSULATED TERMINAL LUGS. Small copper wires (sizes #22 through #10) are terminated with solderless pre-insulated straight copper terminal lugs conforming to Specification MIL-T-7928 and Military Standard MS 25036. As shown in Figure 5–2, the insulation is part of the terminal lug and extends beyond its barrel, so that it will cover a portion of the wire insulation; this makes the use of an insulation sleeve unnecessary. In addition, all pre-insulated terminal lugs contain an insulation-grip (a metal reinforcing sleeve) beneath the insulation, for extra gripping strength on the wire insulation.

5–8. Pre-insulated terminals accommodate more than one size of wire; the insulation is color-coded, as shown in Table XXXII, to identify the wire sizes that can be terminated with each of the terminal lug sizes.

5–9. CRIMPING TOOLS. Hand, portable power and stationary power tools are available for crimping terminal lugs. These tools crimp the barrel to the conductor, and simultaneously crimp the insulation grip to the wire insulation. Use the standard tool MS 25037

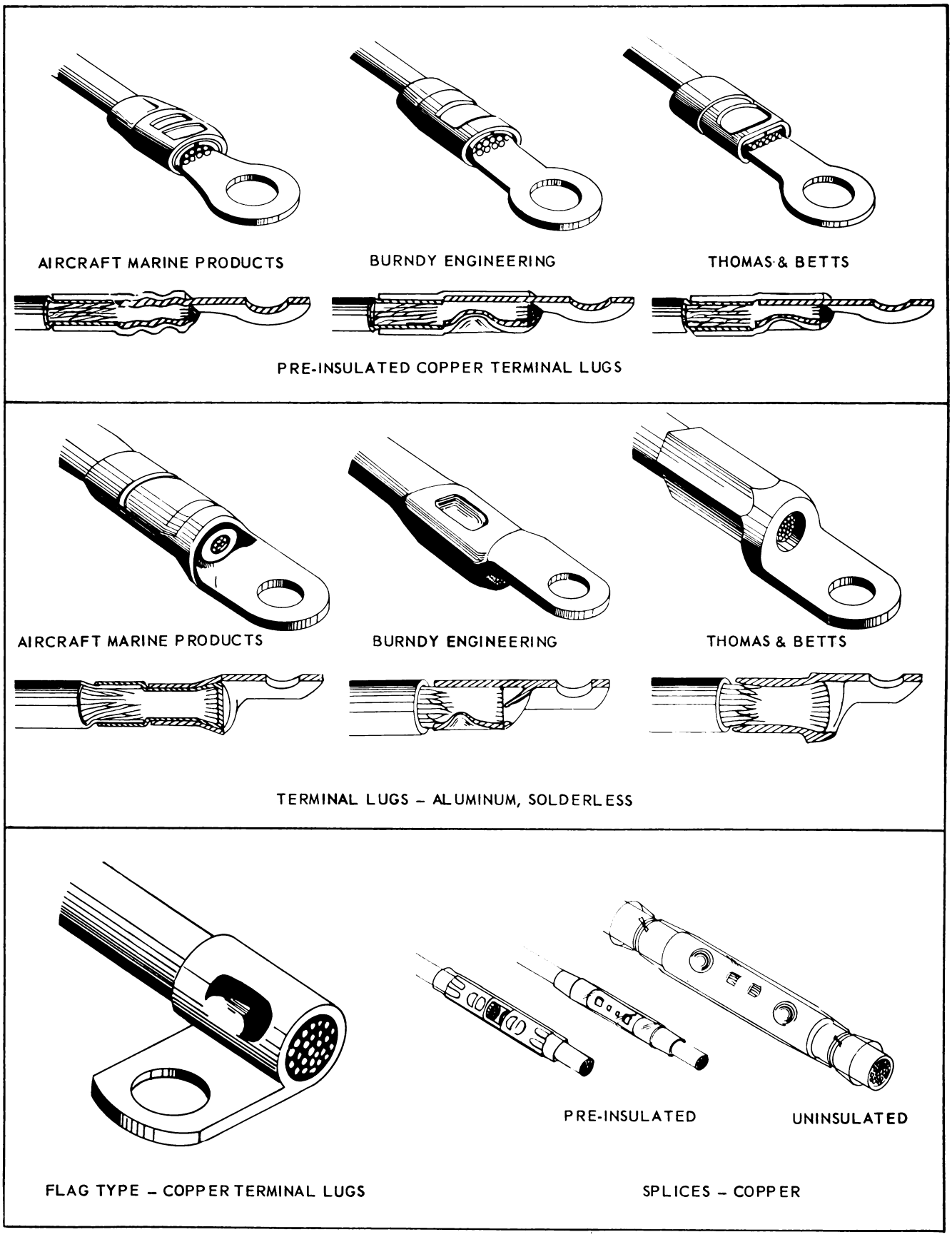


Figure 5–1. Terminal Lugs & Splices – Solderless

for the standard copper terminal lugs MS 25036. Use the crimping tools of each manufacturer for the non-standard terminal lugs of the same manufacturer. The crimping tools most commonly used are listed in this manner in Table XXXIII.

TABLE XXXII

Color-Coding of COPPER Terminal Lug Insulation

Color of Terminal Lug Insulation	*To be used on Wire Sizes*
Red	#22 through #18
Blue	#16 and #14
Yellow	#12 and #10

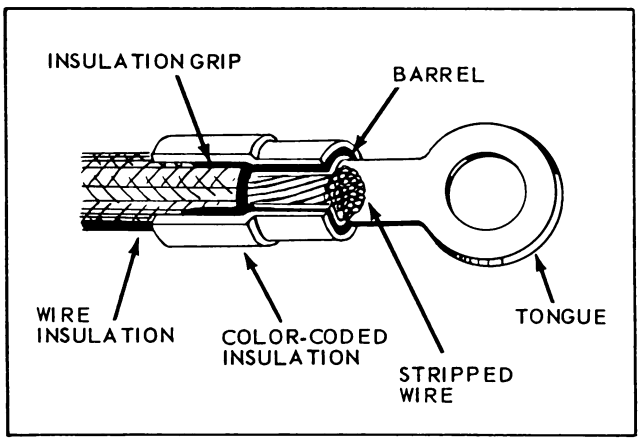


Figure 5–2. Pre-Insulated Terminal Lug – Cutaway

5–10. HAND TOOLS. Hand crimping tools must all have a self-locking ratchet. This ratchet prevents opening tool until crimp is complete. This mechanism must never be disassembled since it insures proper crimping pressure. See Figure 5–3.

5–11. Hand tool sizes are identified as follows:

a. The standard tool MS 25037 has nests identified by color-coded arrows. (Figure 5–3d)

b. AMP hand tools are used on one terminal lug size only. Each size tool is color-identified to match color of terminal lug insulation. Tool jaws are also size-marked. (Figures 5–3a, b & e)

c. Burndy tools have nests which are size-marked and also color-coded at each opening. (Figure 5–3c)

d. The Thomas & Betts tool has nests identified by color-coded arrows. (Figure 5–3d)

5–12. HAND TOOL INSPECTION. The standard tool, MS 25037, and all AMP, Burndy, and T & B hand tools are checked by means of gages for proper adjustment of crimping jaws. For good crimping results, this is done before each series of crimping operations. Return hand tools which are out of tolerance to manufacturer for repair. Check tools as follows:

a. The Military Standard tool MS 25037 is checked when fully closed. A #36 (.106) drill rod shall not be able to enter the smaller (Red & Blue) nest.

b. AMP tools are checked with the tool fully bottomed. The gap between the barrel crimping jaws and the gap between the insulation crimping jaws and the gap between the insulation crimping jaws shall meet the requirements of Table XXXIV. Note that the "GO" gages shall be able to enter between the jaws, and the "NO GO" gages shall be unable to enter.

TABLE XXXIII

Copper Terminal Lugs (small) & Crimping Tools

Terminal Lug Insulation Color	*Hand Tools*	*Portable Power Tools*		*Stationary Power Tools*	
		Tool Number	*Insert Name and Number*	*Tool Number*	*Insert Name and Number*
1) *MS 25036:*					
Red, Blue & Yellow	Std. Tool MS 25037	–	–	–	–
2) *AMP:*					
Red	48430 49556 59170	69005 69010	Head 38082 Head 48336	69004 69011 69012	Press Dies 49563 Head 38789 Head 48496
Blue	48431 49557 59170	69005 69010	Head 38080 Head 37480	69004 69011 69012	Press Dies 49564 Head 38793 Head 48520
Yellow	59062 59118	69010	Head 38645	69004 69012	Press Dies 49480 Head 37211
3) *Burndy*					
Red, Blue & Yellow	MR8-33T	Y8ND	Die Set N10ET-9	Y10NCP	Die Set R10ET-3
4) *T & B*					
Red, Blue & Yellow	WT-145	11901 11902	Die 11952 Die 11952	21017 21022	Die 21645 Die 21635

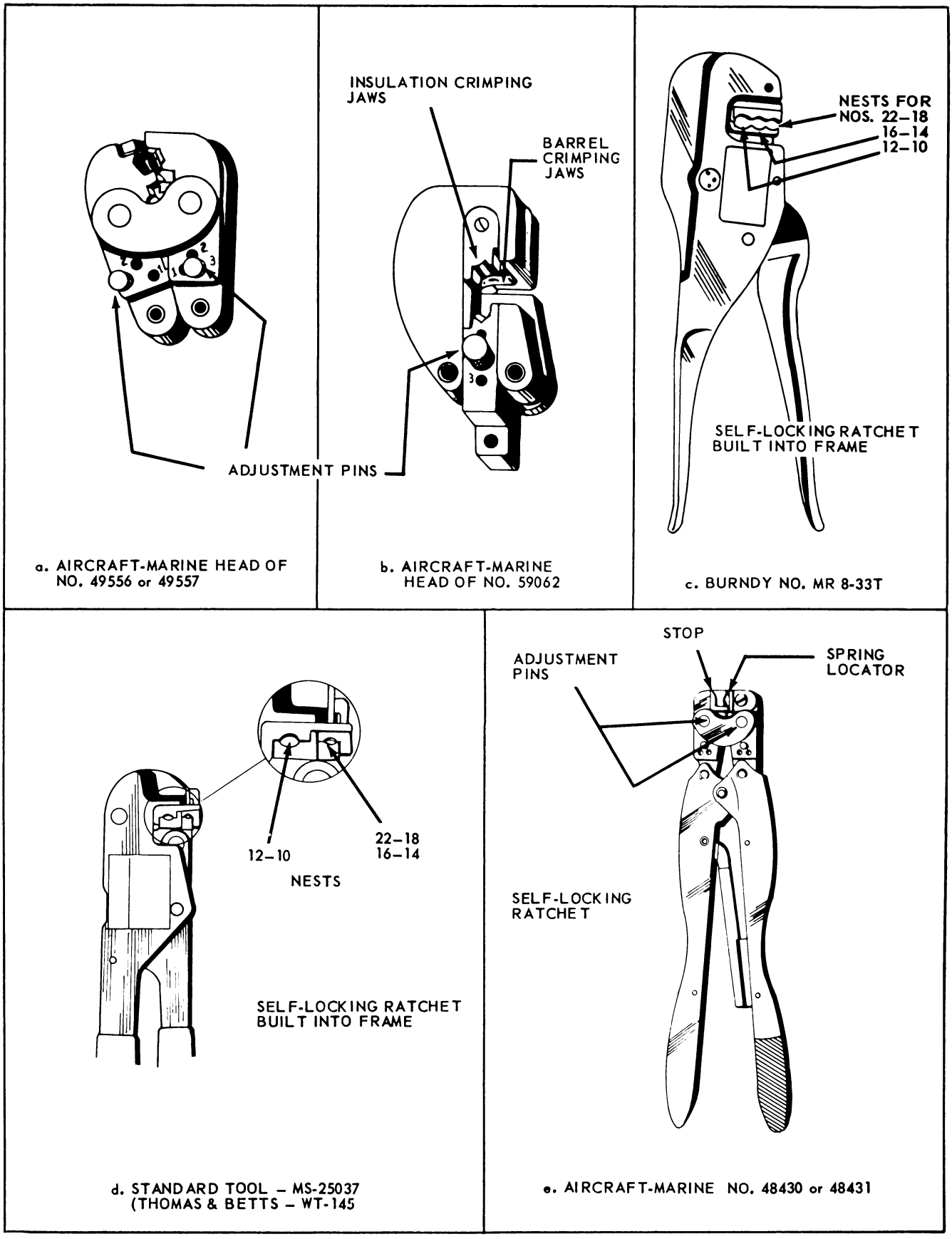


Figure 5–3. Tools – Hand Crimping – Pre-Insulated

TABLE XXXIV

Gaging Dimensions for AMP Tools

Tool Wire Size Range	*Gaging Dimensions (inches)*			
	For Barrel Crimping Jaws		*For Insulation Crimping Jaws*	
	GO	*NO GO*	*GO*	**NO GO*
22–16	.098	.104	.030	.090
16–14	. 108	.114	.040	.100
12–10	.139	.145	.064	.139

*When tools have adjustment pins, (see par. 5–13) GO gaging is done with pins in position No. 1 and NO GO gaging with pins in position No. 3.

c. T & B hand tool No. WT-145 is checked when fully closed. No. 36 (.106) drill shall not be able to enter the smaller (Red & Blue) nest.

d. Check Burndy hand tool MR8-33T & MR8-33S when fully closed. The gap in the 22-18 (red) nest shall accept an .076 diameter rod and shall not accept an .093 diameter rod.

5–13. AMP HAND TOOL INSULATION GRIP ADJUSTMENT. The amount of closing of the insulation crimping jaws is adjustable by means of one or two pins for various wire insulation thicknesses. See Figure 5–3a. Table XXXV lists the pin position to be used in each case.

TABLE XXXV

Position for AMP Hand Tool Adjustment Pins

Size of Wire Insulation	*Position of Adjustment Pin or Pins**
Small (MIL-W-5086)	#1
Medium (MIL-W-5274	#2
Large	#3

5–14. POWER TOOLS. Power crimping tools operate on air pressure. Power trigger must be depressed until crimp is complete. As indicated in Table XXXIII power tools use specific inserts, called "Heads", "Dies", "Die Sets" or "Press Dies", for each terminal lug size. Use correct insert for each terminal lug being crimped. See Figure 5–4 and Table XXXIII for details.

WARNING

ALWAYS disconnect power tool from its air pressure source, BEFORE installing or removing insert.

5–15. POWER TOOLS INSPECTION & ADJUSTMENT. AMP, Burndy and T & B power tools are checked by means of gages for proper adjustment. For good crimping results, this is done before each series of crimping operations. When the tool is adjustable, make proper correction; otherwise, return tool to manufacturer for repair. Check tools as follows:

a. AMP power tools, except tool No. 69004, are checked with the tool fully bottomed. The gap between the barrel crimping jaws and the gap between the insulation crimping jaws shall meet the requirements of Table XXXIV. Note that the "GO" gages shall be able to enter the jaws and the "NO GO" gages shall be unable to enter. AMP power tools are not adjustable in the field.

b. AMP tool No. 69004 is checked by placing a piece of tissue weight (.002 inches) paper between the dies; when the dies are bottomed, with a terminal of the correct size in place, the paper shall not pull free when pulled. If the paper pulls free, the tool needs adjustment by means of a crimp adjustment screw shown in Figure 5–4c.

c. T & B power tool No. 21017 (with Die #21645) and tool No. 21022 (with Die #21635) are checked by closing the dies over a No. 38 (.101) drill inserted in the smaller nest (for Red & Blue terminal lugs). The crimp adjustment screw is then tightened until the drill cannot be removed. Checking is required each time the insert is replaced.

d. T & B portable power tools No. 11901 & 11902 (with Die #11952) are checked with same drill as the stationary power tools. The 11901 & 11902 are not adjustable in the field and must be returned to the manufacturer if out of adjustment.

e. Check Burndy tool Y10NCP, with die set #R10ET-3 closed. The gap in the 22-18 (red) nest shall accept and.087 diameter rod and shall not accept a .105 diameter rod. Replace dies that are out of tolerance.

f. Check Burndy tool Y8ND, with die set #N10ET-9 when fully closed. The gap in the 12-10 (yellow) nest shall accept a .140 diameter rod and shall not accept a .146 diameter rod. Replace dies that are out of tolerance.

5–16. CRIMPING PROCEDURE FOR MS 25037 – STANDARD HAND TOOL. Hand crimp all pre-insulated copper terminal lugs in the #22-10 wire size range with MS 25037 standard hand tool as follows:

a. Strip wire insulation (lengths are given in Table XXXVI). Use one of recommended stripping procedures in Section II, paragraphs 2–37 through 2–43.

b. Check tool for correct adjustment in accordance with paragraph 5–12. Tools out of adjustment must be returned to manufacturer for repairs.

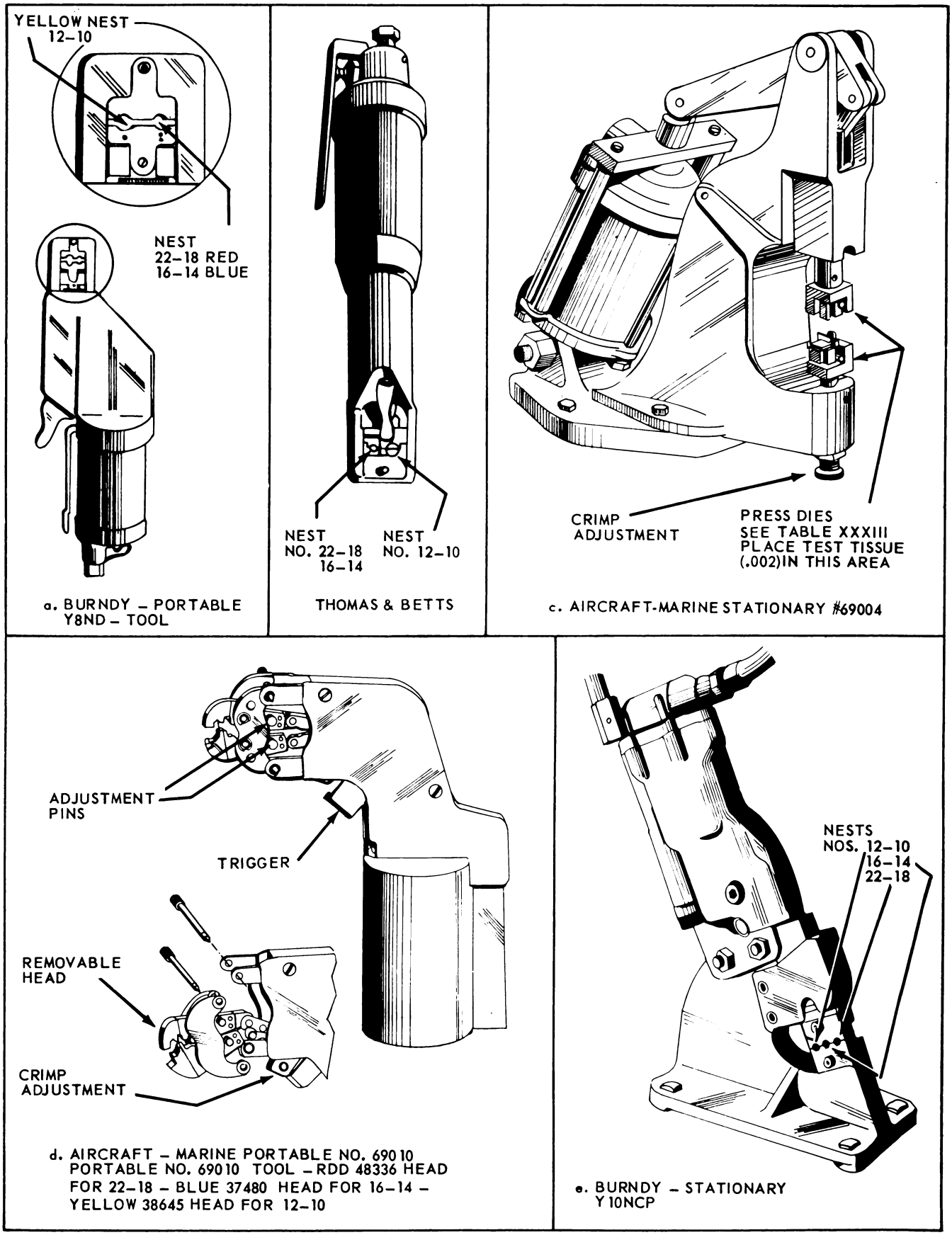


Figure 5–4. Tools – Power Crimping – PreInsulated Copper

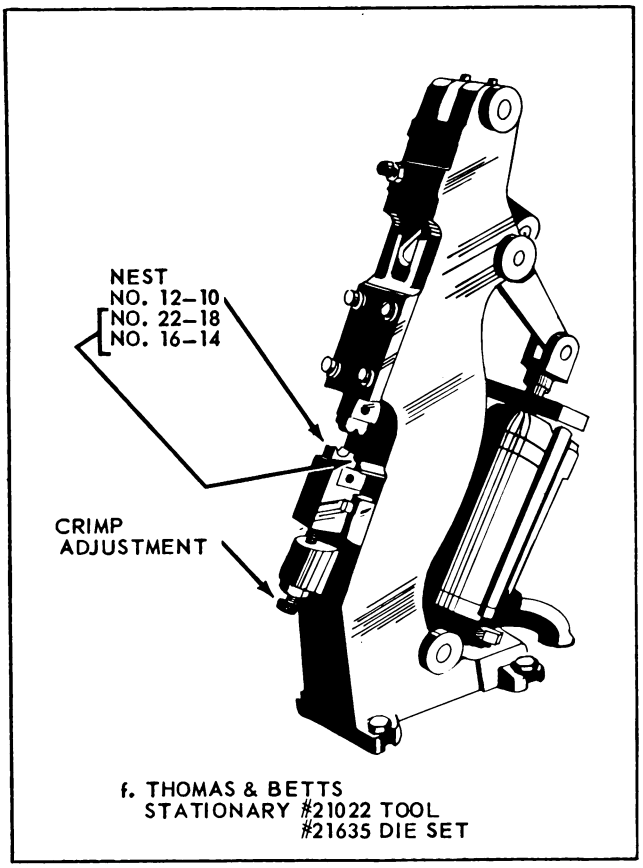


Figure 5–4. Tools – Power Crimping – PreInsulated Copper (Cont'd)

c. Insert terminal lug, tongue first, into hand tool barrel crimping jaws, until terminal lug barrel butts flush against tool stop. See Figure 5–5 for correct and incorrect insertion methods.

d. Squeeze tool handles slowly, until tool jaws hold terminal lug barrel firmly in place, but without denting it.

e. Insert stripped wire into terminal lug barrel until wire insulation butts flush against end of barrel.

f. Squeeze tool handles until ratchet releases.

g. Remove completed assembly and examine it for proper crimp, in accordance with paragraph 5–61.

5–17. CRIMPING PROCEDURE FOR AMP HAND TOOLS. Hand crimp AMP copper, pre-insulated terminal lugs with AMP hand tools as follows:

a. Strip wire insulation, using recommended stripping practices described in Section II, paragraphs 2-37 through 2–43; stripping lengths are given in Table XXXVI.

TABLE XXXVI

Wire Stripping Lengths for Small Copper Terminal Lugs

Wire Size	*Stripping Length* (in inches)
#22 through #14	3/16
#12 & #10	9/32

b. Select, from Table XXXIII, a hand tool for terminal lug size being crimped. Use MS 25037 if available.

c. Check tool for correct adjustment in accordance with paragraph 5–12.

d. When using tools No. 48430, 48431, 49556, 49557, 59062 or 59118, set insulation crimp adjustment pins to correct position in accordance with paragraph 5–13.

e. Make sure that stop-plate is in position for use with terminal lugs. See Figures 5–5a & d.

f. Insert terminal lug, tongue first, into hand tool barrel crimping jaws, until terminal lug barrel butts flush against tool stop. See Figure 5–5 for correct and incorrect insertion methods.

g. Squeeze tool handles slowly, until tool jaws hold terminal lug barrel firmly in place, but without denting it.

h. Insert stripped wire into terminal lug barrel until wire insulation butts flush against end of barrel inside terminal lug pre-insulation. See Figure 5–2.

i. Squeeze tool handles until ratchet releases.

j. Remove completed assembly and examine it for proper crimp, in accordance with paragraph 5–61.

NOTE

AMP tools impress a code in the crimp area to certify use of proper tool. A tool for #22-18 (Red) terminals raises a single dot in this area. A tool for #16-14 (Blue) terminals raises double dots in this area. A tool for #12-10 (Yellow) terminals raises a single dot in this area. Red terminals will not be crimped at all in the yellow terminal tool, and it is impossible to insert a yellow terminal in the red terminal tool.

5–18. CRIMPING PROCEDURE FOR BURNDY HAND TOOLS. Hand-crimp Burndy copper, pre-insulated terminal lugs with Burndy hand tools as follows:

a. Strip wire insulation, using recommended stripping practices described in Section II, paragraphs 2–37 through 2–43; stripping lengths are given in Table XXXVI above.

b. Select hand tool from Table XXXIII.

c. Make sure that removable stop-plate of tool No. MR8-1A is present on tool if that tool is used.

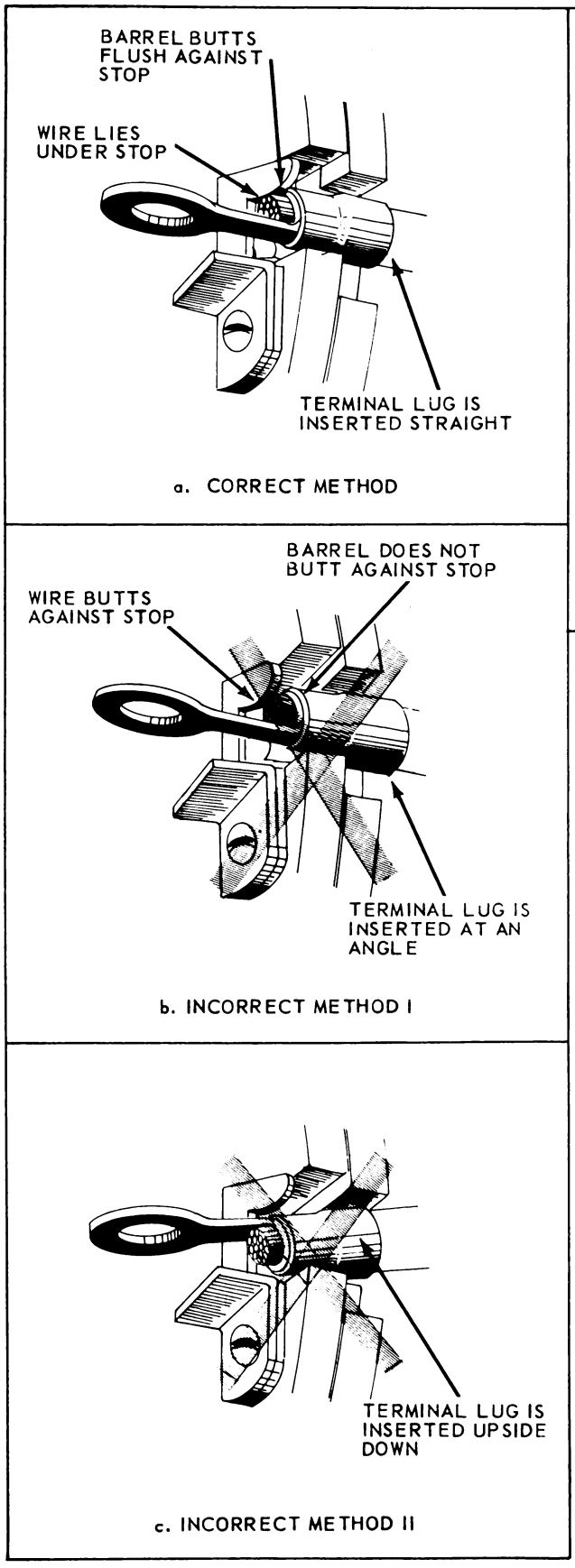
d. Insert terminal lug, tongue first, into hand tool barrel crimping jaws until terminal lug barrel butts flush against tool stop. See Figure 5–5 for correct and incorrect insertion methods.

e. Squeeze tool handles slowly, until tool jaws hold terminal lug barrel firmly in place, but without denting it.

f. Insert stripped wire into terminal lug barrel until wire insulation butts flush against end of barrel.

g. Squeeze tool handles until ratchet releases.

h. Remove completed assembly and examine it for proper crimp in accordance with paragraph 5–61.



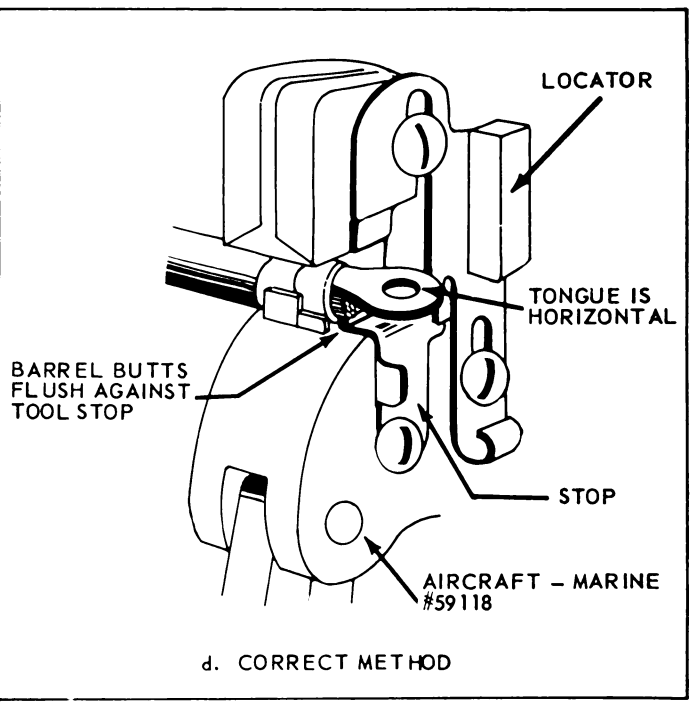


Figure 5–5. Inserting Terminal Lug Into Handtool

5–19. CRIMPING PROCEDURE FOR T & B HAND TOOL. Hand-crimp T & B copper, pre-insulated terminal lugs with T & B hand tool as follows:

a. Strip wire insulation, using recommended stripping practices described in Section II, paragraphs 2–37 through 2–43; stripping lengths are given in Table XXXVI.

b. Check tool for correct adjustment in accordance with paragraph 5–12.

c. Insert terminal lug, tongue first, into hand tool barrel crimping jaws, until terminal lug barrel butts flush against tool stop. See Figure 5–5 for correct and incorrect insertion methods.

d. Squeeze tool handles slowly, until tool jaws hold terminal lug barrel firmly in place, but without denting it.

e. Insert stripped wire into terminal lug barrel until wire insulation butts flush against end of barrel.

f. Squeeze tool handles until ratchet releases.

g. Remove completed assembly and examine it for proper crimp, in accordance with paragraph 5–61.

5–20. CRIMPING PROCEDURE FOR AMP POWER TOOLS. Power-crimp AMP, copper, pre-insulated terminal lugs with AMP power tools as follows:

a. Strip off wire insulation, using recommended stripping practices described in Section II, paragraphs 2–37 through 2–43; stripping lengths are given in Table XXXVI.

b. Select, from Table XXXIII, a power tool and its proper insert for the terminal lug size being crimped.

WARNING

ALWAYS disconnect power tool from its pressure source, BEFORE installing or removing insert.

TABLE XXXVII

Copper Terminal Lugs (Large) & Crimping Tools

Terminal Lugs	*Crimping Tools & Their Size Range* — *Hand*	*Portable Power*	*Stationary Power*
1. *Straight Type Pre-Insulated*			
a. AMP	–	69035 (8-4/0)* (8-2)** (8-2)**	69035 (8-4/0)* (8-2)**
b. Burndy	MY28-6 (8-2/0)	Y29B (8-2/0) Y29NC (8-1/0)	Y29BUC (8-2/0)
2. *Straight Type Uninsulated*			
a. AN659	Std. Tool AN 3427	Std. Insert AND 10460 Dies	Std. Insert AND 10460 Dies
b. Burndy	MY28 (8-4/0) or AN 3427	Y29B (8-4/0) Y29NC (8-2/0)	Y29NSC (8-2/0)
c. T & B	WT 115 (8-2) WT 127 (2-4/0)	11030 (using Nests & Indentor Set No. 21019) (2-4/0)	21022 (using Die No. 21640) (8-2) 21073 (2-4/0)
3. *Right-Angle Type Insulated*			
a. Burndy	MY28-6 (8-2/0)	Y29B (8-2/0) Y29NC (8-1/0)	Y29BUC (8-2/0)
4. *Right-Angle Type Uninsulated*			
a. Burndy	AN 3427 or MY28	Y29B (8-4/0) Y29NC (8-2/0)	–
b. T & B	WT 115 (8-2) WT 127 (2-4/0)	11030 (using Nests & Indentor Set No. 21019) (2-4/0)	21022 (using Die No. 21640) (8-2) 21073 (2-4/0)
5. *Flag Type Uninsulated*			
a. Burndy	AN 3427 or MY28	Y29B (8-2/0) Y29NC (8-1/0)	Y29NSC (8-1/0)
b. T & B	WT 129 (8-2)	11029 (using Nests & Indentor Set No. 11065) (2-4/0)	–

*Using Head No. 69056 with proper dies for each wire size.
**Using Head No. 69051 with proper dies for each wire size.

c. Install insert in tool.

d. Check tool for proper adjustment in accordance with paragraph 5–15.

e. On all power tools, except No. 69004, check that removable stop plate is present on insert. When using tools No. 69005 and 69010, set adjustment pins to correct position in accordance with paragraph 5-13.

f. Insert stripped wire into terminal lug barrel until wire insulation butts flush against end of barrel.

g. Insert wire and terminal lug assembly in tool, until terminal lug barrel butts flush against tool stop. (When tool has no stop, center terminal lug barrel

h. Squeeze tool trigger, or actuate foot treadle.

i. Remove completed assembly and examine it for proper crimp in accordance with paragraph 5–61.

5–21. CRIMPING PROCEDURE FOR BURNDY POWER TOOLS. Power-crimp Burndy solderless, copper, pre-insulated terminal lugs with Burndy power tools, as follows:

a. Strip off wire insulation, using recommended stripping practices described in Section II, paragraphs 2–37 through 2–43; stripping lengths are given in Table XXXVI.

b. Select, from Table XXXIII, power tool that fits crimping conditions best and its proper insert.

c. When using tool No. Y10NCP, check that removable stop-plate is present on insert.

WARNING

ALWAYS disconnect power tool from its pressure source, BEFORE installing or removing insert.

d. Install insert in tool.

e. Insert stripped wire into terminal lug barrel until wire insulation butts flush against end of barrel.

f. Insert wire and terminal lug assembly in tool, until terminal lug barrel butts flush against tool stop. (When tool has no stop, center terminal lug barrel under indentor.)

g. Squeeze tool trigger, or actuate foot treadle.

h. Remove completed assembly and examine it for proper crimp in accordance with paragraph 5–61.

5–22. CRIMPING PROCEDURE FOR T & B POWER TOOLS. Power-crimp T & B copper, pre-insulated terminal lugs with T & B power tools, as follows:

a. Strip off wire insulation, using recommended stripping practices described in Section II, paragraphs 2–37 through 2–43; stripping lengths are given in Table XXXVI.

b. Select, from Table XXXIII, power tool that fits crimping conditions best and its proper insert.

WARNING

ALWAYS disconnect power tool from its pressure source, BEFORE installing or removing insert.

c. Install insert in tool.

d. Check power tools for proper adjustment in accordance with paragraph 5–15. The portable tools cannot be adjusted in the field . must be returned to manufacturer.

e. Insert stripped wire into terminal lug barrel until wire insulation butts flush against end of barrel.

f. Insert wire and terminal lug assembly in tool, until terminal lug barrel butts flush against tool stop. (When tool has no stop, center terminal lug barrel under indentor.)

g. Squeeze tool trigger, or actuate foot treadle.

h. Remove completed assembly and examine it for proper crimp in accordance with paragraph 5–61.

5–23. TERMINATING LARGE COPPER WIRES (SIZES NO. 8 THROUGH 4/0).

5–24. TERMINAL LUGS. Copper terminal lugs of all three types, straight, right-angle and flag, are used to terminate copper wires of sizes No. 8 through 4/0. The type to be used depends on existing space conditions. As indicated in Table XXXVII, these terminal lugs are available uninsulated in all three types, and pre-insulated in the straight and right-angle types, though not necessarily in all wire sizes or from all manufacturers. As shown in Figure 5–2, pre-insulated terminal lugs have the insulation cemented to the terminal lug and extending beyond the barrel, so that it will cover a portion of the wire insulation. This makes the use of a separate insulating sleeve unnecessary. The straight uninsulated terminal lugs conform to specification MIL-T-5042 and Std. Dwg. AN659.

5–25. INSULATING SLEEVES. Uninsulated straight and right-angle type terminal lugs are insulated, after assembly to wire, by means of pieces of transparent flexible tubing, called "sleeves". The sleeve provides electrical and mechanical protection at the connection. When the size of sleeving used is such that it will fit tightly over the terminal lug, the sleeving need not be tied; otherwise, it is tied with lacing cord. (See Figure 5–6.) Tight fitting sleeves are expanded in methyl-ethyl-ketone solvent before installation. When the solvent evaporates, the sleeve will shrink tightly over the terminal lug.

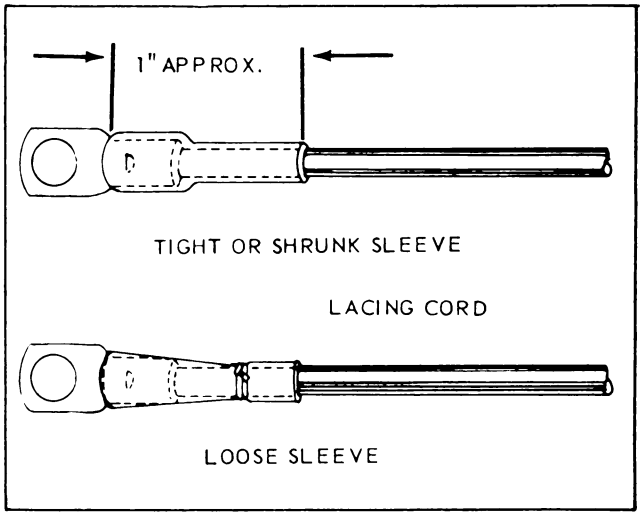


Figure 5–6. Insulating Sleeves

WARNING

Methyl-ethyl-ketone is highly inflammable.

5–26. CRIMPING TOOLS. Hand, portable power and stationary power tools are available for crimping large copper terminal lugs. The crimping tools used on the pre-insulated terminal lugs, crimp the barrel to the conductor, and simultaneously crimp the terminal lug insulation to the wire insulation. For best results, it is desirable that the crimping tools of each manufacturer be used for the terminal lugs of the same manufacturer. The crimping tools most commonly used are listed in this manner in Table XXXVII. The numbers

in parentheses beneath the tool numbers, indicate the range of terminal lug sizes the tool can crimp; do not use any tools for lateral terminal lug sizes than listed as this will result in poor connections.

NOTE

Use power tools for large terminal lugs whenever possible.

5–27. HAND TOOLS. Hand crimping tools are available for AN659, Burndy and T & B large copper terminal lugs. These tools are illustrated in Figure 5–7. The AN3427 and the Burndy hand tools, No. MY28 and MY28–6, each have a single nest and indentor; the nest is adjustable by means of a screw to the proper position for each terminal lug size. Note the shape of the indentor in Figure 5–7a. It is used for crimping copper terminal lugs; do not confuse it with the indentor used for aluminum terminals as shown in Figure 5–19. T & B tools, No. WT 115 and WT 129 each have a single indentor and a nest wheel containing a specific nest for each terminal lug size; the nests are identified by means of letters, which correspond to terminal lug sizes, as listed on the tools themselves. T & B tool No. WT 127 requires a different nest for each terminal lug size to be crimped; these nests are listed in Table XXXVIII.

TABLE XXXVIII

Nests for T & B Hand Tool WT 127

Terminal Lug Size	*T & B corresponding identification letter*	*T & B Nest No.*
2	G	21651
1	H	21652
1/0	J	21653
2/0	K	21654
3/0	L	21655
4/0	M	21656

5–28. HAND TOOL ADJUSTMENT. The AN Standard Hand Tool AN 3427 has two positioning plates as shown in Figure 5–7a. One plate is for installing one-piece terminal lugs and the other is for installing two-piece and flag type terminal lugs. Adjust the position of each plate as follows:

a. Adjust "one-piece terminal" position plate to indicator guide line of No. 8 and No. 6 when an .090 diameter pin is just held by indentor and nest.

b. Adjust "two-piece and flag type terminal position plate to indicator guide line of No. 8 and No. 6 when an .120 diameter pin is just held by indentor and nest.

5–29. The Burndy hand tool MY-28 is similar to Standard Tool AN 3427 and is adjusted the same way.

5–30. Thomas & Betts hand tools WT 115 and WT 129 are not adjustable and must be returned to the manufacturer if the following check reveals any defects.

a. Nest D should accept a 5/32 inch (.156) diameter pin when tool is fully closed.

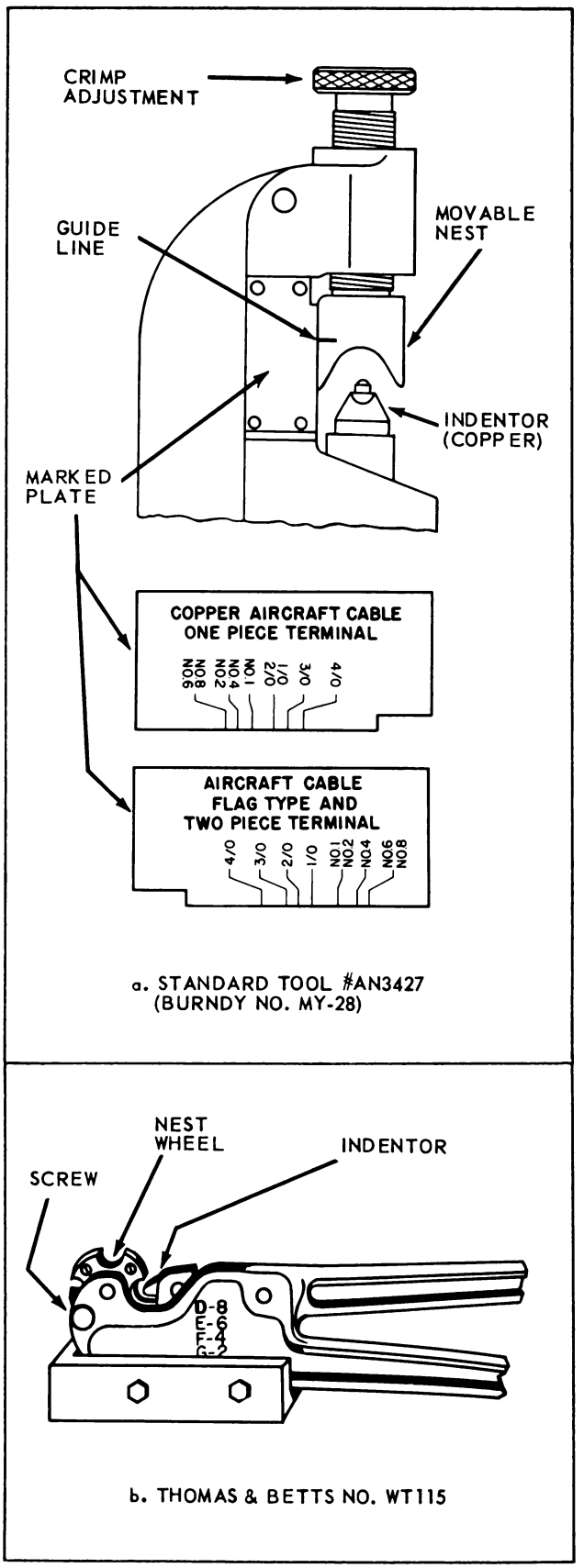
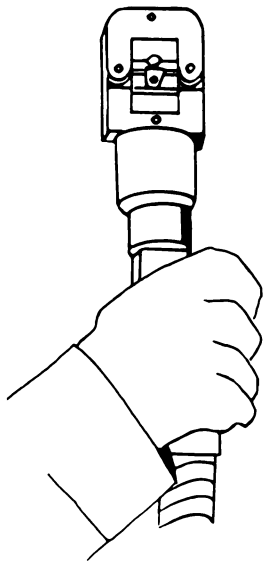
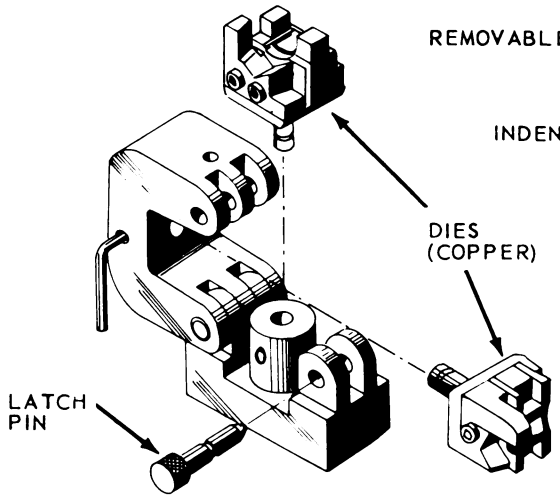


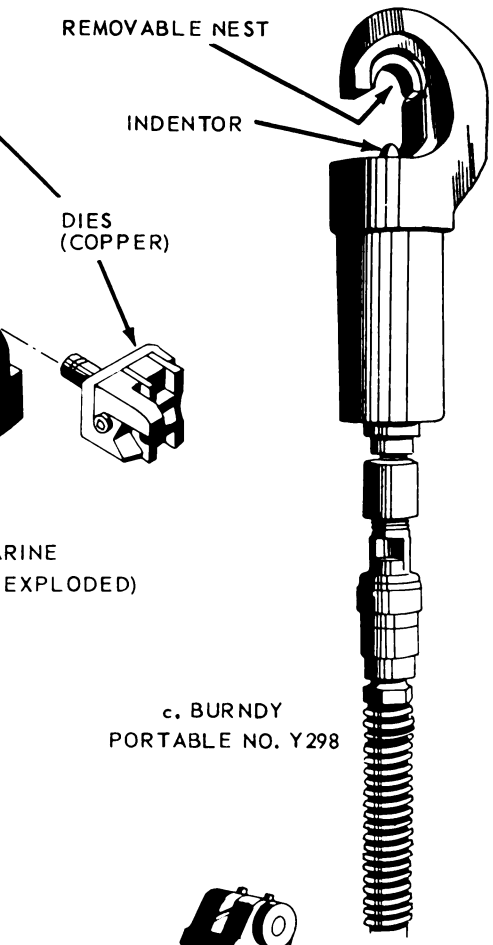
Figure 5–7. Tools – Hand Crimping Large Copper Terminal Lugs



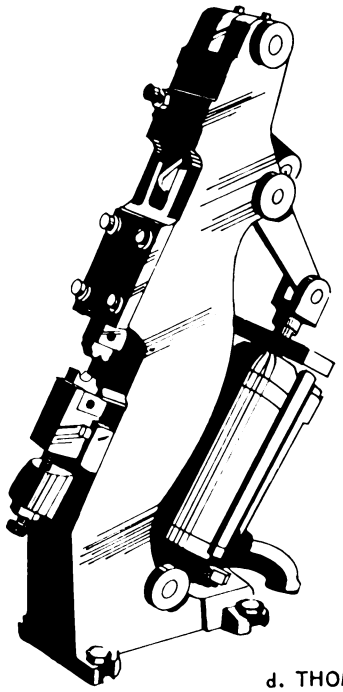
a. AIRCRAFT–MARINE
PORTABLE NO. 69035



b. AIRCRAFT–MARINE
PORTABLE NO. 69035 (EXPLODED)



c. BURNDY
PORTABLE NO. Y298



d. THOMAS & BETTS
STATIONARY NO. 21022
DIE NO. 21640 FOR #8 – #2

Figure 5–8. Tools – Power Crimping – Large Copper Terminal Lugs

b. Nest D should *not* accept a .166 diameter pin when tool is fully closed.

5–31. POWER TOOLS. The power crimping tools, both portable and stationary, operate on air pressure, except for T & B tool No. 11029, which operates on hydraulic pressure.

5–32. AMP power tool dies are listed in Table XXXIX. Each terminal lug size requires a special die set.

5–33. Each Burndy power tool, except tool No. Y29BUC, requires a different die set, nest and indentor combination, for each size and type of terminal lug. These die sets are listed in Table XL for uninsulated terminal lugs, and in Table XLI for pre-insulated terminal lugs. Burndy tool No. Y29BUC, uses two rack and indentor combinations, as listed in Table XL.

5–34. T & B power tool No. 21022 requires only one die for all terminal lug sizes; the die number is included in Table XXXVII. T & B power tool Nos. 11029 and 11030 need nest and indentor sets listed in Table XXXVII. T & B power tool, No. 21073, has a nonremovable nest wheel containing 6 nests and a single indentor; the nests are identified by letters G to M, corresponding to terminal lug sizes 2 to 4/0. See Figure 5–8 for illustrations of power tools.

WARNING

ALWAYS disconnect power tool from its pressure source, BEFORE installing or removing its insert.

TABLE XXXIX
Dies for AMP Power Tools No. 69035

Terminal Lug Size	*AMP Die Number For Head No. 69051*	*For Head No. 69056*
8	48752	
6	48753	
4	48754	
2	48755	
1/0		48756
2/0		48757
3/0		48758
4/0		48759

5–35. POWER TOOLS ADJUSTMENT. AMP, Burndy and T & B power tools can be checked for proper adjustment. For good crimping results, this must be done before each series of crimping operations. When tool is adjustable, proper correction must be made; otherwise, tool must be returned to manufacturer for repair. Check tools as follows:

a. AMP tool No. 69035 is checked with tool fully bottomed. Gap between barrel crimping jaws of the dies shall meet the requirements of Table XLII. Note that "GO" gages shall be able to enter between jaws, and "NO GO" gages shall be unable to enter.

b. Burndy tools Y29B, Y29BUC and Y29NC when equipped with nests and indentors for PRE-INSULATED terminal lugs (Table XLI) are checked to "G" dimensions listed in Table XLIII. The "G" dimension is the clearance between nest and indentor when the tool is fully bottomed.

c. T & B power tool No. 11029 is checked when fully bottomed. The gap between the indentor and the various nests shall meet the requirements of Table XLIV. Note that "GO" gages shall be able to enter gap, and "NO GO" gages shall be unable to enter.

d. T & B power tool No. 21022 is checked by inserting 3/16 inch (.187) drill in nest E and closing the tool. The drill shall be held tightly between the nest and the indentor.

e. T & B power tool No. 21073, is checked when tool is fully bottomed. A 11/32 inch (.344) drill shall enter between nest K and the indentor, and a 23/64 inch (.360) drill shall not enter.

5–36. CRIMPING PROCEDURE FOR AN3427 STANDARD HAND TOOL. (Burndy Tool #MY-28). Hand

TABLE XL
Die Sets for Burndy Power Tools No. Y29B, Y29NC & Y29NSC

Terminal Lug Size	*For Use on Straight & Tight-Angle Type UNINSULATED Terminal Lugs*		*For Use on Flag Type UNINSULATED Terminal Lugs*	
	Nest No.	*Indentor No.*	*Nest No.*	*Indentor No.*
8	DV8L	Y29PL	DV8B	Y29PBL
6	DV6L	Y29PL	DV6L	Y29PBL
4	DV4L	Y29PL	DV4BL	Y29PBL
2	DV2L	Y29PL	DV2BL	Y29PL
1	DV1L	Y29PL	–	–
1/0	DV25L	Y29PR	DV25BL	Y29PR
2/0	DV26L	Y29PR	*DV28L	*Y29PR
3/0	*DV27L	*Y29PR	–	–
4/0	*DV28L	*Y29PR	–	–

*Use these nests & indentors on tool No. Y29B only, since tools No. Y29NC & Y29NSC are not powerful enough to be used on terminal lugs of this size.

TABLE XLI
Die Sets for Burndy Power Tools No. 629B, Y29NC & Y29BUC for PRE-INSULATED COPPER Terminal Lugs

Terminal Lug Size	*Burndy Die Set Number for Straight and Right Angle Terminal Lugs*			
	For Tools No. Y29B & Y29NC		*For Tool No. Y29BUC*	
	Nest No.	*Indentor No.*	*Rack No.*	*Indentor No.*
8	DEV8L	Y29PLE-1	Y29BUR-7	Y29PU5
6	DEV6L	Y29PLE-1	Y29BUR-7	Y29PU5
4	DEV4L	Y29PLE-1	Y29BUR-7	Y29PU5
2	DEV2L	Y29PLE	Y29BUR-8	Y29PU1
1	DV26L	Y29PLE	Y29BUR-8	Y29PU1
1/0	DEV25L	Y29PLE	Y29BUR-8	Y29PU1
2/0	*DEV26L	*Y29PLE	Y29BUR-8	Y29PU1

*Use this nest & indentor on tool No. Y29B only, since tool No. Y29NC is not powerful enough to be used on terminal lugs of this size.

TABLE XLII

Gaging Dimensions for AMP Tools

AN Wire Size	*Gaging Dimensions (in inches)*	
	GO	*NO GO*
8	.200	.208
6	.236	.244
4	.268	.276
2	.318	.326
1/0	.399	.409
2/0	.445	.455
3/0	.497	.507
4/0	.559	.569

TABLE XLIII

"G" Dimensions for Burndy Power Tools

AN Wire Size	*"G" Dimension (in inches)*					
	Y29B		*Y29BUC*		*Y29NC*	
	MAX	*MIN*	*MAX*	*MIN*	*MAX*	*MIN*
8	.121	.094	.147	.132	.111	.084
6	.176	.149	.172	.157	.166	.139
4	.186	.161	.192	.177	.176	.151
2	.216	.184	.210	.190	.206	.174
1	.296	.266	.290	.270	.286	.256
1/0	.325	.295	.320	.300	.315	.285
2/0	–	–	.340	.320	.335	.305

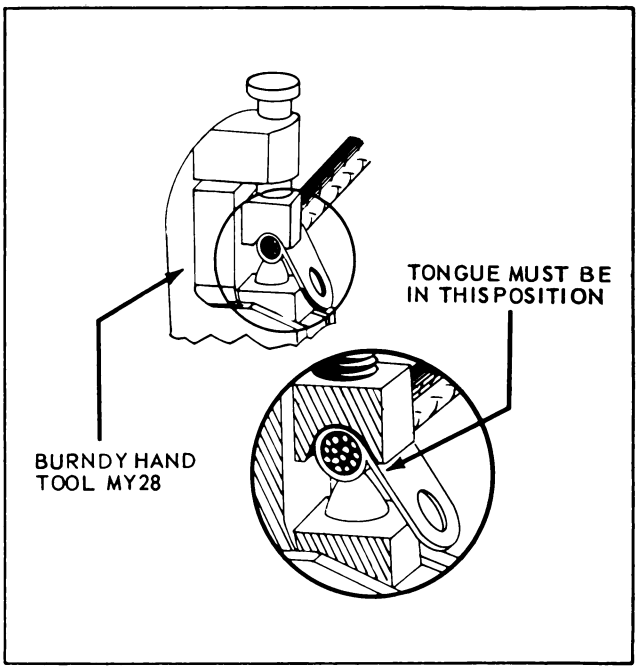


Figure 5–9. Positioning Flag Type Terminal Lugs

TABLE XLIV

Gaging Dimensions for T & B Tool No. 11029

Nest Identification Letter	*Corresponding Wire Size*	*Gaging Drill Size (in inches)*		
		GO		*NO GO*
G	2	17/64 (.265)	I	(.272)
H	1	K (.281)	L	(.290)
J	1/0	5/16 (.312)	O	(.316)
K	2/0	23/64 (.359)	U	(.368)
L	3/0	W (.386)	25/64	(.390)
M	4/0	7/16 (.437)	29/64	(.453)

crimping of large copper terminal lugs, is done as follows with Standard Tool AN 3427 (Burndy #MY-28).

a. Strip wire insulation as described in Section II, paragraphs 2–37 through 2–43. Stripping lengths are given in Table XLV.

b. Set tool to proper crimping position by use of adjustment screw. (See Figure 5–7a.)

c. Slide insulating sleeve (see paragraph 5–25) over wire insulation, well clear of crimping area. Do not use insulating sleeves with flag type terminal lugs.

d. Insert stripped wire into terminal lug barrel until wire insulation butts flush against end of barrel.

e. Insert wire and terminal lug assembly in tool nest. Center barrel under tool indentor. Close tool handles all the way (until movable handle reaches fixed stop).

NOTE

Tongue of flag type terminal lug must rest flat against upper bevel of nest as shown in Figure 5–9.

f. Remove completed assembly and examine it for proper crimp, in accordance with paragraph 5–61.

g. Slide insulating sleeve over terminal lug barrel and secure it in accordance with paragraph 5–25 and Figure 5–6.

5–37. CRIMPING PROCEDURE FOR T & B HAND TOOLS. Hand-crimp large T & B copper terminal lugs as follows:

a. Strip off wire insulation, using recommended practices described in Section II, paragraphs 2–37 through 2–43; stripping lengths are given in Table XLV.

b. Select, from Table XXXVII, the proper hand tool for terminal lug type being crimped.

c. Check tool for correct adjustment in accordance with paragraph 5–23.

d. Prepare tool for crimping as follows:

1. Tools No. WT 115 and WT 129, loosen thumbscrew, turn nestwheel until proper nest for terminal lug size being crimped is opposite indentor and retighten thumbscrew.

2. Tool No. WT 127, insert proper nest for terminal lug size being crimped, in accordance with Table XXXVIII.

e. Slide insulating sleeve (see paragraph 5–25) over wire insulation well clear of crimping area. Do not use insulating sleeves with flag type terminal lugs.

f. Insert stripped wire into terminal lug barrel until wire insulation butts flush against end of barrel.

g. Insert wire and terminal lug assembly in tool nest. Center barrel under tool indentor.

h. Close tool handles all the way (until movable handle reaches fixed stop).

i. Remove completed assembly and examine it for proper crimp, in accordance with paragraph 5–61.

j. Slide insulating sleeve over terminal lug barrel and secure it, in accordance with paragraph 5–25 and Figure 5–6.

5–38. CRIMPING PROCEDURE FOR AMP POWER TOOLS. Power-crimp large AMP copper pre-insulated terminal lugs as follows:

TABLE XLV

Wire Stripping Lengths for Large Copper Terminal Lugs

I. *When Assembling to Straight Type Terminal Lugs*

Stripping Length (in inches)

Wire Size	*When Assembling to UNINSULATED Straight Type Terminal Lugs of*		*When Assembling to PRE-INSULATED Straight Type Terminal Lugs of*	
	Burndy	*T & B*	*AMP*	*Burndy*
8	7/16	1/2	5/16	13/32
6	1/2	1/2	15/32	15/32
4	1/2	1/2	15/32	15/32
2	5/8	11/16	15/32	19/32
1	5/8	11/16	–	19/32
1/0	11/16	25/32	25/32	1/2
2/0	13/16	27/32	25/32	25/32
3/0	13/16	27/32	25/32	–
4/0	7/8	29/32	25/32	–

II. *When Assembling to Right-Angle Type Terminal Lugs*

Stripping Length (in inches)

Wire Size	*When Assembling to UNINSULATED Right-Angle Type Terminal Lugs of*		*When Assembling to PRE-INSULATED Right-Angle Type Terminal Lugs of*
8	*Burndy*	*T & B*	*Burndy*
8	13/16	1/2	3/8
6	13/16	1/2	7/16
4	13/16	1/2	7/16
2	7/8	11/16	9/16
1	7/8	11/16	9/16
1/0	11/16	25/32	5/8
2/0	13/16	27/32	3/4
3/0	13/16	27/32	–
3/0	7/8	29/32	–

III. *When assembling to Flag Type Terminal Lugs*

Wire Size	*Stripping Length (in inches)* *When Assembling to UNINSULATED Flag Type Terminal Lugs of*		
	Burndy	*T & B*	*AMP*
8	1/2	9/16	13/32
6	1/2	9/16	17/32
4	9/16	21/32	19/32
2	5/8	11/16	23/32
1	–	3/4	–
1/0	11/16	7/8	29/32
2/0	13/16	7/8	31/32
3/0	–	7/8	1-3/32
4/0	–	7/8	1-5/32

a. Strip wire insulation, using recommended stripping practices described in Section II, paragraphs 2–37 through 2–43; stripping lengths are given in Table XLV.

b. Select the proper insert for the terminal lug size being crimped from Table XXXIX.

WARNING

ALWAYS disconnect a power tool from its pressure source, whether air or hydraulic BEFORE installing or removing its insert.

c. Install insert in tool.

d. Check tool for proper adjustment in accordance with paragraph 5–35.

e. Insert stripped wire into terminal lug barrel until wire insulation butts flush against end of barrel.

f. Insert wire and terminal lug assembly in tool nest, so that terminal lug barrel butts flush against tool stop.

g. Squeeze tool trigger, or actuate foot treadle.

h. Remove completed assembly and examine it for proper crimp in accordance with paragraph 5–61.

5–39. CRIMPING PROCEDURE FOR BURNDY POWER TOOLS. Power-crimp large Burndy copper terminal lugs as follows:

a. Strip wire insulation, using recommended stripping practices described in Section II, paragraphs 2–37 through 2–43; stripping lengths are given in Table XLVI.

b. Select, from Table XXXVII, a power tool for terminal lug type and size being crimped. Pick tool that fits crimping conditions best.

c. Select proper insert for tool from Tables XL or XLI, depending on terminal lug type. Nest and indentor must have same identification letter.

WARNING

1. ALWAYS disconnect power tool from its pressure source, BEFORE installing or removing its insert.
2. Tool No. Y29BUC, nest rack must ALWAYS be removed BEFORE installing or removing indentor.

d. Install insert in tool.

e. Slide insulating sleeve over wires to be connected to uninsulated terminal lugs (see paragraph 5–25). Do not use insulating sleeves for flag type terminals.

f. Insert stripped wire into terminal lug barrel until wire insulation butts flush against end of barrel.

g. Insert wire and terminal lug assembly in tool nest. Center barrel under indentor.

h. Squeeze tool trigger or actuate foot treadle.

i. Remove completed assembly and examine it for proper crimp in accordance with paragraph 5–62.

j. Where used, slide insulating sleeve over terminal lug barrel and secure, in accordance with paragraph 5–25 and Figure 5–6.

TABLE XLVI

ALUMINUM Terminal Lugs & Crimping Tools

Aluminum Terminal Lugs	*Crimping Tools & Wire Size Range*		
	Hand	*Portable Power*	*Stationary Power*
1. *Straight Type Lug*	Mil Std. Tool		
a. MS 25021	MS 25020	–	–
b. AMP	–	69035 (8-4/0)*	69035 (8-4/0)*
c. Burndy	MY28-4 (8-4/0)	Y29B (8-4/0) Y29NC (8-1/0)	Y29NSC (8-1/0)
d. T & B	–	21093 (8-2)	21094 (8-4/0) 21920 (8-4/0)
2. *Right-angle Type Lug*			
a. Burndy	MY28-4 (8-4/0)	Y29B (8-4/0) Y29NC (8-1/0)	–
b. T & B	–	21093 (8-2)	21094 (8-4/0) 21920 (8-4/0)
3. *Flag Type Lug*	Mil Std. Tool		
a. MS 25022	MS 25020	–	–
b. Burndy	MY28-4 (8-1/0)	Y29B (8-4/0) Y29NC (8-1/0)	Y29NSC (8-1/0)
c. T & B	–	21093 (8-2)	21094 (8-4/0) 21920 (8-4/0)

*With Crimping Head No. 69056. For other heads see wire size limitations in Table XLV.

TABLE XLVII

Dies used on AMP Tools #69035 when Crimping ALUMINUM Terminal Lugs, Sizes #8 to #4/0

Lug Size	*AMP Die Number*	
	For Head #69051	*For Head #69056*
8	48874	–
6	48875	–
4	48876	–
2	–	48823
1/0	–	48824
2/0	–	48825
3/0	–	48826
4/0	–	–

5–40. CRIMPING PROCEDURE FOR T & B POWER TOOLS. Power-crimp large T & B copper terminal lugs as follows:

a. Strip wire insulation, using recommended stripping practices described in Section II, paragraphs 2-37 through 2-43; stripping lengths are given in Table XLV.

b. Select, from Table XXXVII, a power tool for terminal lug type and size being crimped. Pick tool that fits crimping conditions best.

c. Set tool No. 21073 by rotating nest wheel to index proper nest opposite indentor. Install correct nest in other tools.

d. Slide insulating sleeve over wires to be connected to uninsulated terminal lugs (see paragraph 5–25). Do not use insulating sleeves for flag type terminals.

e. Insert stripped wire into terminal lug barrel until wire insulation butts flush against end of barrel.

f. Insert wire and terminal lug assembly in tool nest. Center barrel under indentor.

g. Squeeze tool trigger or actuate foot treadle.

h. Remove completed assembly and examine it for proper crimp in accordance with paragraph 5–61.

i. Where used, slide insulating sleeve over terminal lug barrel and secure, in accordance with paragraph 5–25 and Figure 5–6.

5–41. TERMINATING ALUMINUM WIRE.

5–42. Aluminum wire is used in aircraft because of its weight advantage over copper. Aluminum, however, has the disadvantage of being softer than copper. Further, bending aluminum wire will cause "work hardening" of the metal which makes it more brittle. This will result in failure or breakage of strands much sooner than for copper. Aluminum also forms a high resistance oxide film immediately upon exposure to air. To compensate for these disadvantages it is important to carefully follow the recommended installation procedures.

WARNING

Do not use any aluminum wire which has nicked or broken strands. Damaged strands will fail in service.

5–43. ALUMINUM TERMINAL LUGS. Aluminum terminal lugs are only used to terminate aluminum wires. See Figure 5–1 for sample connections. Aluminum terminal lugs are available in three types: straight, right-angle and flag. All aluminum terminals have an inspection hole, which permits checking depth of wire insertion (see Figure 5–12). The barrel of all aluminum terminal lugs is filled with a petrolatum-zinc dust compound. This compound, by a grinding process during the crimping operation, removes the oxide film from the aluminum. The compound will also minimize later oxidation of the completed connection by excluding moisture and air. The compound is retained inside the terminal lug barrel by a plastic or foil seal at the end of the barrel.

CAUTION

To prevent loss or contamination of compound DO NOT REMOVE SEAL until just prior to crimping operation.

5–44. INSULATING SLEEVES. Aluminum terminal lugs are not pre-insulated, therefore it is necessary to insulate them after assembly, by means of transparent flexible tubing, called "sleeves". The sleeve provides mechanical and electrical protection at the connection. See Figure 5–6.

5–45. CRIMPING TOOLS. Hand, portable power, and stationary power tools are used to install aluminum terminal lugs. The Military Standard tool MS-25020 is recommended for the installation of aluminum straight type terminal lug MS-25021 and for flag type terminal lug MS-25022. Other aluminum terminal lugs must be installed with the tools listed in Table XLVI. The numbers in parentheses listed below the tool numbers indicate the range of wire sizes that can be crimped safely.

CAUTION

Do not use any crimping tool for wires beyond its rated capacity.

5–46. HAND TOOLS. The hand tool, Burndy No. MY28-4, is similar to Burndy tool No. MY28, used for uninsulated copper terminal lugs, except for the shape of the indentor. See Figure 5–10. Make sure the proper shaped indentor is installed in the MY28-4 tool for use on aluminum terminal lugs.

5–47. POWER TOOLS. The AMP and Burndy power tools operate on air pressure. The T & B power tools operate on hydraulic pressure. All power tools require a specific insert die set, for each terminal lug size. These inserts are listed in Tables XLVII through XLIX. See Figure 5–11 for examples of power tools.

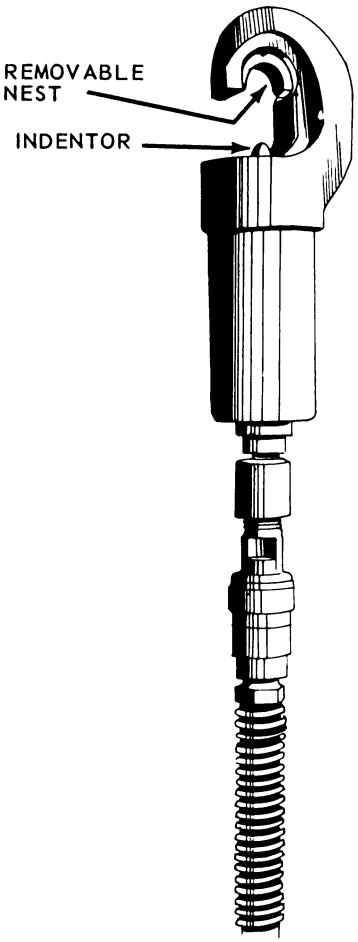
5–48. CRIMPING PROCEDURE FOR MILITARY STANDARD AND BURNDY HAND TOOLS. Hand-crimp with the MILITARY STANDARD Tool MS-25020 and Burndy MY28-4 as follows:

a. Set tool to proper crimping position for terminal lug size being crimped. This is done by moving nest by means of adjustment screw until guide line on nest is centered over line on marked plate corresponding to terminal lug size being crimped. See Figure 5–10.

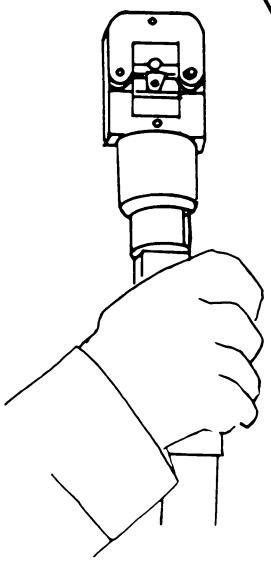
b. Carefully strip wire insulation, using recommended stripping practices for aluminum wire described in Section II, paragraphs 2–37 through 2–43; stripping lengths are listed in Table L.

c. When crimping straight or right-angle type terminal lugs, slip insulating sleeve over wire insulation, well clear of crimping area.

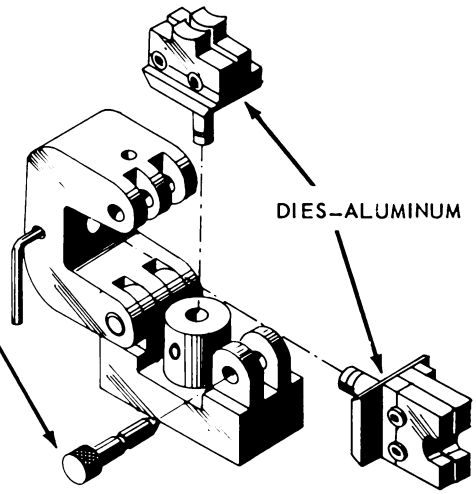
d. Remove protective cover from terminal lug barrel. See Figure 5–12.



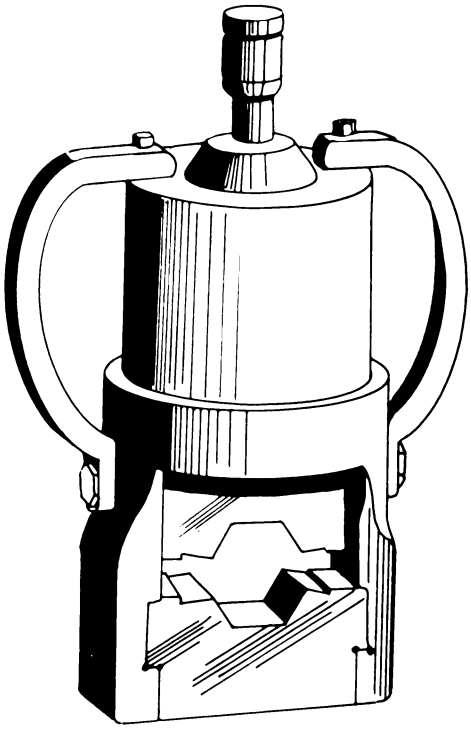
a. BURNDY – PORTABLE
NO. Y29B



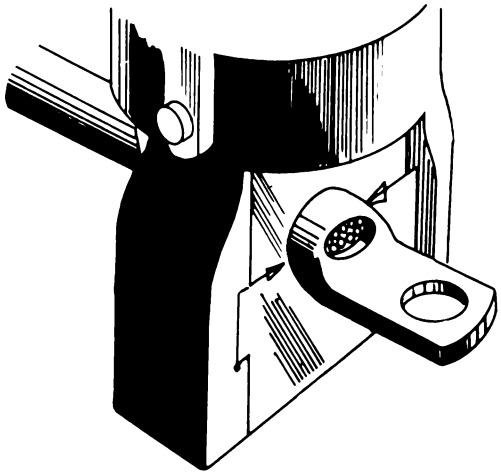
b. AIRCRAFT – MARINE
– PORTABLE NO. 69035



c. AIRCRAFT – MARINE –
PORTABLE – NO. 69035 (EXPLODED)



d. THOMAS & BETTS
– STATIONARY HEAD NO. 21094



e. THOMAS & BETTS – STATIONARY HEAD NO. 21094
WITH TERMINAL LUG IN PLACE

Figure 5–11. Tools – Power Crimping – Aluminum Terminal Lugs

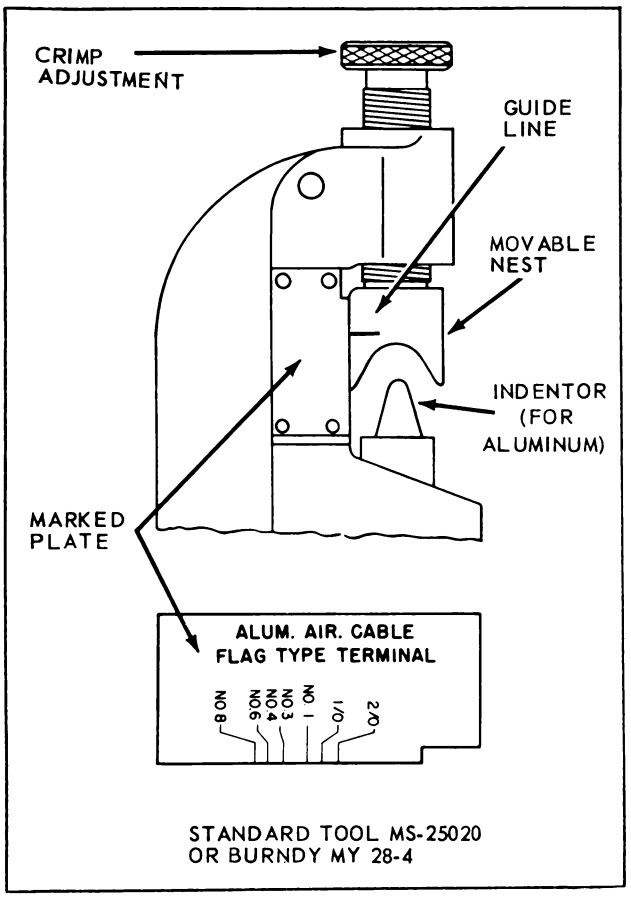


Figure 5–10. Tool – Hand Crimping – Aluminum Terminals

e. Check that terminal lug barrel is at least half-full of petrolatum-zinc dust compound. If not, add additional compound.

f. Hold terminal lug in one hand, with finger fully blocking inspection hole to prevent loss of compound, and pick up wire in other hand.

g. Insert stripped wire into terminal lug barrel. Do not twist wire during insertion.

h. Hold wire and terminal lug assembly firmly together and wipe off any excess compound squeezed out of terminal lug barrel with a soft dry cloth.

i. Check inspection hole, visually or with a wire probe, and make sure that wire end reaches all the way into terminal lug barrel.

j. Insert wire and terminal lug assembly into tool, so that terminal lug barrel is centered over tool indentor. Tongue of flag type terminal lug must rest flat against side of tool nest. See Figure 5–9.

k. Close tool handles until movable handle reaches.

l. Remove completed assembly from tool.

m. Wipe off excess compound squeezed out of terminal lug barrel with a soft dry cloth.

n. Examine assembly for proper crimp in accordance with paragraph 5–62.

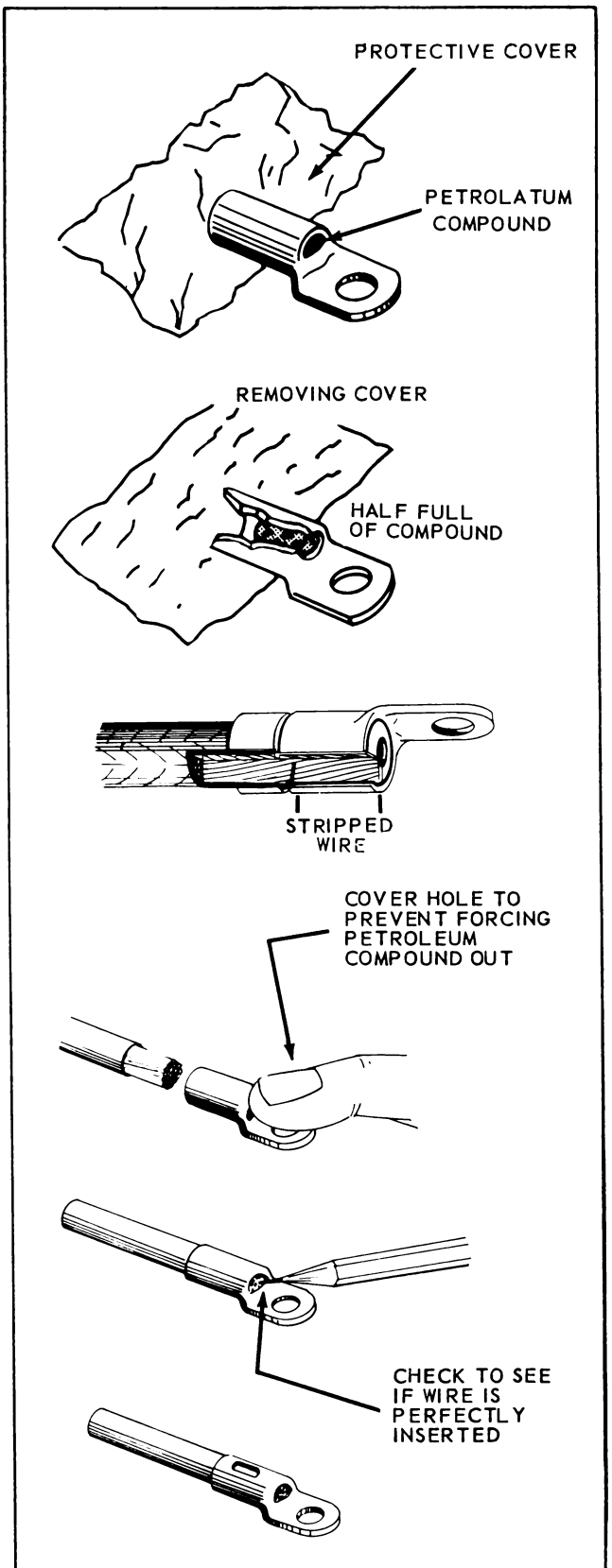


Figure 5–12. Inserting Aluminum Wire Into Burndy AMP and T & B Aluminum Terminal Lugs

TABLE XLVIII

Die Sets used on Burndy Power Tools Y29B, Y29C & Y29NSC, when Crimping ALUMINUM Terminal Lugs, Sizes #8 to #4/0

Lug Size	*Die Sets*			
	*For Straight and Right-angle Type Terminal Lugs**		*For Flag Type Terminal Lugs*	
	Nest	*Indentor*	*Nest*	*Indentor*
8	DV8L-1	Y29PL	DV8B	Y29PBL
6	DV6L-1	Y29PL	DV6L	Y29PBL
4	DV4L	Y29PLA	DV4BL	Y29PBL
2	DV2L	Y29PLA	DV2BL	Y29PLA
1	DV25L	Y29PA	DV1BL	Y29PA
1/0	DV26L	Y29PA	DV25BL	Y29PA
2/0	**DV27L	**Y29PA	**DV28L	**Y29PA
3/0	**DV28L	**Y29PA	**DV28L	**Y29PA
4/0	**DV28L	**Y29PA	**DV28L	**Y29PA

*Tool No. Y29NSC is not used on right-angle type terminal lugs. See Table XLVI.

**For use on tool No. Y29B only, since tools Y29NC & Y29NSC are not powerful enough for these terminal lug sizes.

o. Where used, slide insulating sleeve over terminal lug barrel and secure it, in accordance with paragraph 5–25 and Figure 5–6.

5–49. CRIMPING PROCEDURE FOR AMP POWER TOOLS Power-crimp AMP aluminum straight type terminal lugs as follows:

a. Select power tool from Table XLVI.

b. Select proper insert for terminal lug size being crimped from Table XLVII.

WARNING

ALWAYS disconnect power tool from its pressure source, BEFORE installing or removing insert.

c. Install insert in tool.

d. Carefully strip wire insulation to length given in Table L using recommended stripping practices for aluminum wire described in Section II, paragraphs 2–37 through 2–43.

e. Slip insulating sleeve over wire insulation, well clear of crimping area.

f. Remove protective cover from terminal lug barrel.

g. Check that narrow section of thimble is at least half-full of petrolatum-zinc dust compound. If not, add additional compound.

h. Hold finger over inspection hole to prevent loss of compound. Insert stripped wire into terminal lug barrel. Do not twist wire.

i. Hold wire and terminal lug firmly together and wipe off any excess compound squeezed out of thimble with a soft dry cloth.

j. Check inspection hole, visually or with a wire probe and make sure that wire end reaches all the way into terminal lug barrel.

k. Insert wire and terminal lug assembly into tool, so that terminal lug barrel is centered over tool indentor.

l. Actuate power tool.

m. Remove completed assembly from tool.

n. Examine assembly for proper crimp in accordance with paragraph 5–61.

5–50. CRIMPING PROCEDURE FOR BURNDY POWER TOOLS. Power-crimp Burndy aluminum terminal lugs as follows:

a. Select power tool from Table XLVI for terminal lug size and type being crimped. Use tool that fits crimping conditions best.

b. Select proper insert from Table XLVIII.

WARNING

ALWAYS disconnect power tool from its pressure source, BEFORE installing or removing insert.

c. Install insert in tool.

d. Carefully strip wire insulation, using recommended stripping practices for aluminum wire described in Section II, paragraphs 2–37 through 2–43; stripping lengths are listed in Table XLIX.

TABLE XLIX

Dies used on Thomas & Betts Tools for Crimping ALUMINUM Terminal Lugs, Sizes #8 to 4/0

AL Wire Size	*T & B Die Number*		
	For Tool #21093	*For Tool #21094*	*For Tool #21920*
8	21311	21448	11101
6	21312	21449	11102
4	21313	21320	11103
2	21314	21322	11104
1	–	21315	11105
1/0	–	21316	11106
2/0	–	21317	11107
3/0	–	21318	11108
4/0	–	21319	11109

TABLE L

Stripping Lengths for ALUMINUM Wire

Stripping Lengths (in inches)

Wire Size	*When assembled to AMP Straight Type Terminal Lugs*	*When assembled to Burndy Terminal Lugs*			*Straight, Right Angle & Flag Type Terminal Lugs*
	Stripping Length	*Straight Type*	*Right Angle Type*	*Flag Type*	
8	1/2	7/16	13/16	1/2	13/16
6	1/2	1/2	13/16	1/2	15/16
4	9/16	1/2	13/16	9/16	1 1/16
2	13/16	5/8	7/8	*5/8	1 3/16
1	–	3/4	7/8	*3/4	1 3/16
1/0	13/16	13/16	13/16	*13/16	1 3/16
2/0	7/8	15/16	15/16	15/16	1 1/4
3/0	7/8	15/16	15/16	15/16	1 5/16
4/0	15/16	1	1	1	1 15/32

*Except for 1/2 inch stud size terminal lugs, where stripping length is 13/16, 7/8 & 7/8 for wire sizes 2, 1 & 1/0 respectively.

e. When crimping straight or right-angle type terminal lugs, slip insulating sleeve over wire insulation well clear of crimping area.

f. Remove protective cover from terminal lug barrel. See Figure 5–12.

g. Check that terminal lug barrel is at least half-full of petrolatum-zinc dust compound. If not, add additional compound.

h. Hold terminal lug in one hand, with finger fully blocking inspection hole to prevent loss of compound, and pick up wire in other hand.

i. Insert stripped wire into terminal lug barrel. Do not twist wire during insertion.

j. Hold wire and terminal lug assembly firmly together and wipe off any excess compound squeezed out of terminal lug barrel with a soft dry cloth.

k. Check inspection hole, visually or with a wire probe, and make sure that wire end reaches all the way into terminal lug barrel.

l. Insert wire and terminal lug assembly in tool, so that terminal lug barrel is centered under tool indentor.

m. Actuate power tool.

n. Remove completed assembly from tool.

o. Examine assembly for proper crimp in accordance with paragraph 5–61.

p. Where used, slide insulating sleeve over terminal lug barrel and secure it, in accordance with paragraph 5–25 and Figure 5–6.

5–51. CRIMPING PROCEDURE FOR T & B POWER TOOLS. Power-crimp T & B aluminum terminal lugs as follows:

a. Select power tool from Table XLVI. Use tool that fits crimping conditions best.

b. Select proper insert for terminal lug size from Table XLIX.

WARNING

ALWAYS disconnect power tool from its pressure source, BEFORE installing or removing insert.

c. Install insert in tool.

d. Carefully strip wire insulation, using recommended stripping practices for aluminum wire described in Section II, paragraphs 2–37 through 2–43; stripping lengths are listed in Table L.

e. Before crimping straight or right-angle type terminal lugs, slip insulating sleeve over wire insulation well clear of crimping area.

f. Remove protective cover from terminal lug barrel. See Figure 5–12.

g. Check that terminal lug barrel is at least half-full of petrolatum zinc dust compound. If not, add additional compound.

h. Hold terminal lug in one hand, with finger fully blocking inspection hole to prevent loss of compound, and pick up wire in other hand.

i. Insert stripped wire into terminal lug barrel. Do not twist wire during insertion.

j. Hold wire and terminal lug assembly firmly together. Use a soft dry cloth to wipe off any excess compound squeezed out of terminal lug barrel.

k. Check inspection hole, visually or with a probe to make sure that wire end reaches all the way into terminal lug barrel.

l. Insert wire and terminal lug assembly in tool. Center terminal lug barrel under tool indentor.

m. Actuate power tool.

n. Remove completed assembly from tool.

o. Wipe off excess compound squeezed out of terminal lug barrel with a soft dry cloth.

p. Examine assembly for proper crimp in accordance with paragraph 5–61.

q. Where used, slide insulating sleeve over terminal lug barrel and secure it, in accordance with paragraph 5–25 and Figure 5–6.

TABLE LI

Pre-Insulated Copper Splices & Crimping Tools

Splice Wire Size Range	Hand Tools	Portable Power Tools Tool No.	Portable Power Tools Insert No.	Stationary Power Tools Tool No.	Stationary Power Tools Insert No.
1. *AMP:*					
22-18 (Red)	48430 49556*	69005	Head No. 38082*	69004 69011	Press Dies No. 49563* Head No. 38789*
16-14 (Blue)	48431 49557*	69005	Head No. 38080*	69004 69011	Press Dies No. 49564* Head No. 38793*
12-10 (Yellow)	59062* 59118	69010	Head No. 38645*	69004 69012	Press Dies No. 49480* Head No. 37211*
2. *Burndy:*					
20-18(White)	MR8-1A* MR8-33S	–	–	Y10NCP	Die Set No. R10ET-3*
16-14(White)	MR8-1A* MR8-33S	–	–	Y10NCP	Die Set No. R10ET-3*
12-10(White)	MR8-1A* MR8-33S	–	–	Y10NCP	Die Set No. R10ET-3*

*With stop-plate removed

5–52. SPLICING SMALL COPPER WIRES (SIZES No. 22–10).

5–53. PRE-INSULATED SPLICES. Pre-insulated, permanent copper splices are used to join small copper wires of sizes 22 through 10. Sample splices are shown in Figure 5–1. Note that splice pre-insulation extends over the wire insulation. Each splice size can be used for more than one wire size as shown in Table XLVI. AMP splices are color-coded, in the same manner as pre-insulated small copper terminal lugs. Refer to paragraph 5–8 and Table XXXII for details. The splices of other manufacturers are insulated with white plastic. Splices are also used, when authorized, to reduce wire sizes as shown in Figure 5–13.

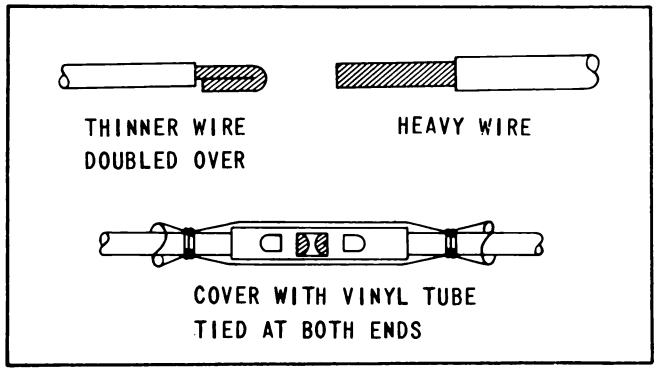


Figure 5–13. Reducing Wire Size with a Permanent Splice

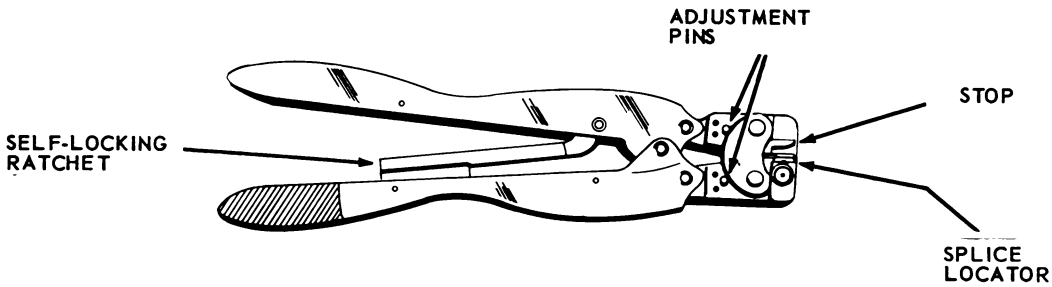
5–54. CRIMPING TOOLS. The crimping tools most commonly used for these splices are listed in Table LI. Note that once again the crimping tools of each manufacturer have been listed only for the splices of the same manufacturer. This is desirable, to obtain good connections. All these tools, except Burndy tool No. MR8–33S, are also used for small pre-insulated copper terminal lugs; therefore, refer to paragraphs 5–10 through 5–15, for descriptions, operating instructions and tool inspection. Some tools must have stop-plate removed before use on splices. These tools are so marked in Table LI.

5–55. CRIMPING PROCEDURES. The crimping procedures, when using hand or power tools, are the same as those described in paragraphs 5–17, 5–18, 5–20 and 5–21 for small pre-insulated copper terminal lugs, with but a few variations; these are as follows:

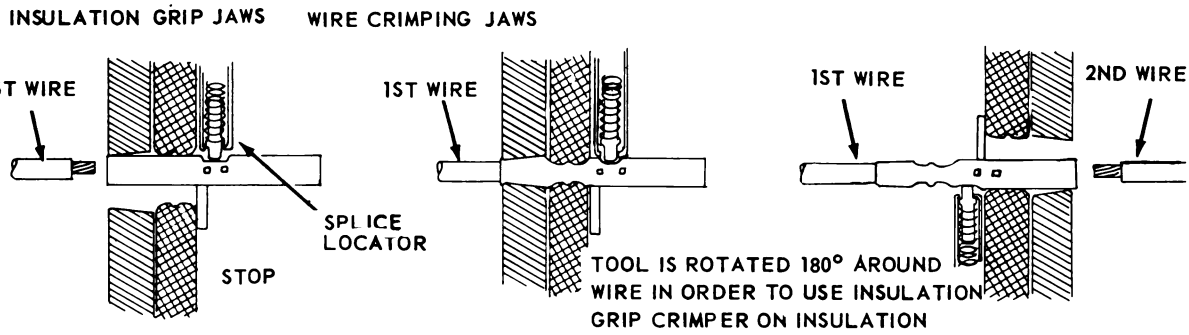
1. Crimping operation must be done twice, once for each end of splice.
2. Wire stripping lengths are different. See Table LII for stripping lengths.
3. When using tools where stop-plate is removed (see Table LI), insert each splice so that splice barrel is centered under tool indentor.
4. AMP tools 48430, 48431 and 59118, each has a splice locator (see Figure 5–14). Insert splice in tool so that locator fits into gap between splice barrels.
5. No. 22 wire can be spliced with #16-14 splice by stripping double length and folding bare conductor back on itself. Use care not to break strands.
6. Observe that each stripped wire is visible thru inspection hole in splice.
7. After crimping check that wire ends are still visible through inspection hole.

5–56. SPLICING LARGE COPPER WIRES (SIZES NO. 8 THROUGH 4/0).

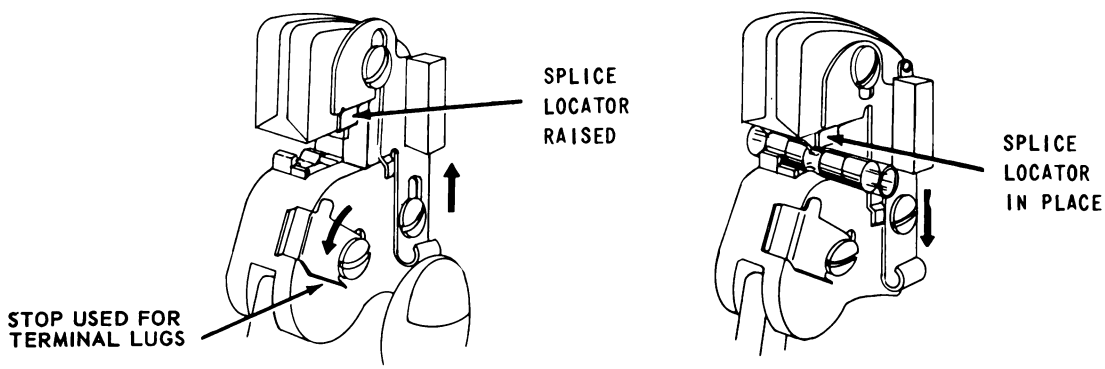
5–57. SPLICES. Uninsulated copper splices made by Burndy are used to join large copper wires of sizes No. 8 through 4/0. There is a different splice for each size of wire. Uninsulated splices are insulated after



a. AIRCRAFT-MARINE NO. 48430 or 48431



b. AIRCRAFT MARINE – NO. 48430 or 48431, SHOWING CROSS SECTION VIEW OF CRIMPING OPERATION



c. AIRCRAFT-MARINE – NO. 59118

Figure 5–15. Tools – Hand Crimping – With Splice Locator

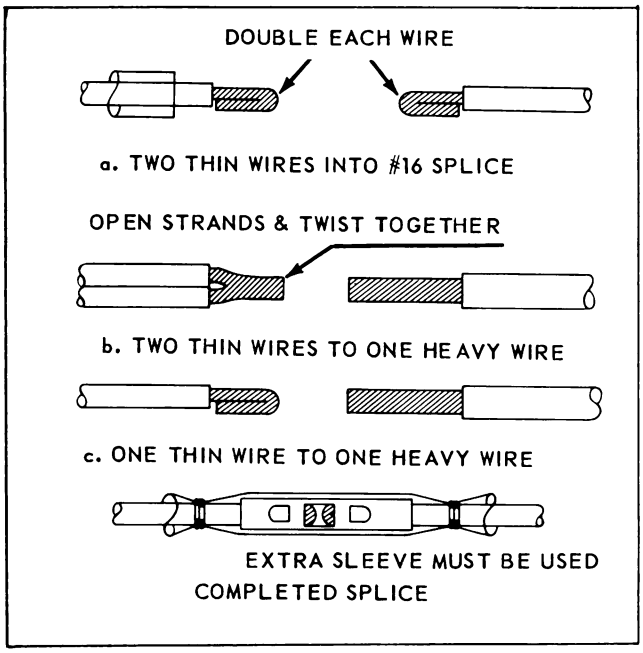


Figure 5–14. Special Splices

assembly with sleeves made of transparent flexible tubing. This sleeving provides electrical and mechanical protection to the connection. Cut to length in accordance with Table LIII. Sleeve to be centered over splice and tied at both ends with lacing cord. See Figure 5–15.

5–58. CRIMPING TOOLS. The crimping tools for Burndy large copper splices are AN 3427 (Standard tool) and MY28, Y29B and Y29NC. AN 3427 and MY28 are hand tools; Y29B and Y29NC are portable air-powered tools which require a different die set for each splice size – these die sets are listed in Table LIV.

NOTE

Use power tools, if available for large copper splices.

5–59. CRIMPING PROCEDURES. The crimping procedures, when using a hand or power tool, are the same as those described in paragraphs 5–36 and 5–39 for large copper terminal lugs, with but few variations; these are as follows:

1. Crimping operation must be done twice, once for each barrel of splice.
2. Wire stripping lengths are in accordance with Table LV.

3. Insulating sleeve is secured at both ends. See Figure 5–15.

5–60. INSPECTION OF CRIMPED CONNECTION.

5–61. VISUAL INSPECTION. Examin- the crimped connection carefully for the following:

a. Indent centered on terminal lug barrel or splice barrels.

TABLE LII

Wire Stripping Lengths for Small Copper Splices

Wire Size	*Stripping Length (in inches) For AMP Splices*	*For Burndy Splices*
22	3/16	1/2*
20 & 18	3/16	1/4
16 & 14	3/16	1/4
12 & 10	9/32	5/16

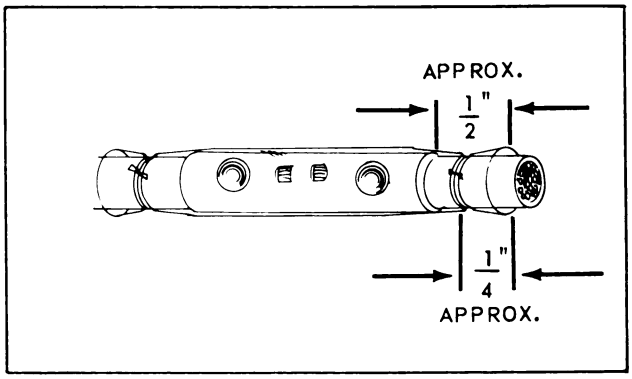


Figure 5–16. Insulating Sleeves for Splices for Size 8 and Larger

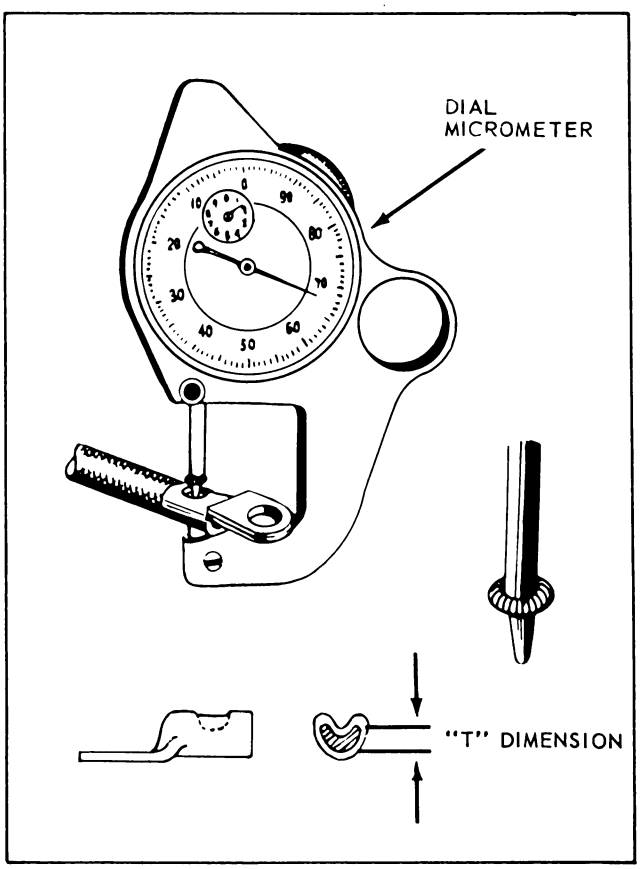


Figure 5–17. Indent Inspection

b. Indent in line with barrel; not cocked.
c. Terminal lug or splice barrel is not cracked.
d. Terminal lug or splice insulation is not cracked.
e. Insulation grip crimped.

CAUTION

Do not use any connection which is found defective in any of the above inspections. Cut off defective connection and remake using a new terminal lug or splice.

5–62. CHECKING DEPTH OF INDENT. Uninsulated terminal lugs and splices crimped with Burndy tools are checked for depth of indent as follows:

1. Use micrometer or depth indicator with point adapter to measure "T" dimension as shown in Figure 5–16.
2. "T" limits for COPPER terminal lugs and splices are listed in Tables LVI and LVII.
3. "T" limits for ALUMINUM terminal lugs are listed in Tables LVIII and LIX.

NOTE

Do not attempt to measure "T" dimensions of insulated terminal lugs. The soft plastic insulation will give a false indication.

5–63. When a dial micrometer is not available, a hand micrometer is modified as shown in Figure 5–17. The indicated "A" dimension must be subtracted from the micrometer reading to obtain the "T" dimension.

TABLE LIII
Length of Insulating Sleeves

Splice Wire Size	*Insulating Sleeve Length (in inches)*
8	1 15/16
6	2 1/8
4	2 1/8
2	2 13/32
1	2 13/32
1/0	2 17/32
2/0	2 25/32
3/0	2 13/16
4/0	2 15/16

TABLE LIV

Die Sets for Burndy Tools Y29B & Y29NC when Crimping Large Copper Splices (Sizes No. 8 through 4/0)

	Die Set Number	
Splice Wire Size	*Nest*	*Indentor*
8	DV8L	Y29PL
6	DV6L	Y29PL
4	DV4L	Y29PL
2	DV2L	Y29PL
1	DV1L	Y29PL
1/0	DV25L	Y29PR
2/0	DV26L	Y29PR
3/0	*DV27L	*Y29PR
4/0	*DV28L	*Y29PR

*For tool No. Y29B only, since tool No. Y29NC is not powerful enough for these sizes.

TABLE LV

Wire Stripping Lengths for Large Copper Splices

AN Wire Size	*Strip Length (inches)*
8	7/16
6	1/2
4	1/2
2	5/8
1	5/8
1/0	11/16
2/0	13/16
3/0	13/16
4/0	7/8

TABLE LVI

"T" Dimensions for Burndy Uninsulated COPPER Splices and Straight & Right-Angle-Type Terminal Lugs

	"T" Dimensions (in inches)			
	Using Burndy Tool No. MY28		*Using Burndy Tools No. No. Y29NC, Y29NSC & Y29B*	
AN Wire Size	*Min.*	*Max.*	*Min.*	*Max.*
8	.090	.120	.096	.150
6	.090	.120	.109	.150
4	.140	.175	.155	.197
2	.140	.180	.195	.236
1	.220	.260	.227	.281
1/0	.280	.320	.252	.306
2/0	.280	.330	.270	.330
3/0	.365	.410	.335	.395
4/0	.410	.455	.320	.380

TABLE LVII

"T" Dimensions for Burndy COPPER Flag Type Terminal Lugs

	"T" Dimensions (in inches)			
	Using Burndy Tool No. MY28		*Using Burndy Tools No. No. Y29B, Y29NC & Y29NSC*	
AN Wire Size	*Min.*	*Max.*	*Min.*	*Max.*
8			.180	.205
6			.205	.235
4			.270	.315
2			.270	.315
1/0			.340	.440
2/0			.405	.465

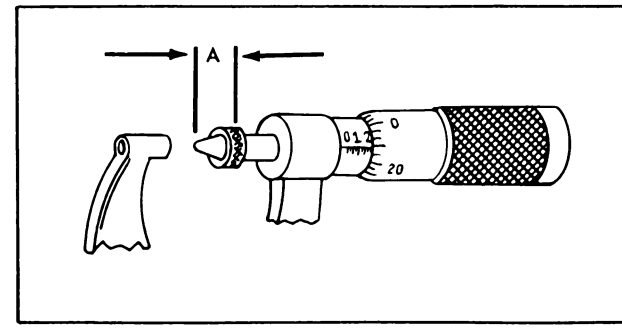


Figure 5–18. Modifying Hand Micrometer for Indent Inspection

TABLE LVIII

"T" Dimensions for Burndy ALUMINUM Straight & Right-Angle Type Terminal Lugs

"T" Dimensions (in inches)

AL Wire Size	Using Burndy Tool No. MY28-4		Using Burndy Tools No. Y29NC, Y29NSC & Y29B	
	Min.	Max.	Min.	Max.
8	.098	.123	.098	.168
6	.125	.150	.125	.150
4	.141	.176	.136	.176
2	.259	.294	.171	.240
1	.290	.320	.204	.280
1/0	.340	.400	.232	.336
2/0	.375	.420	.290	.390
3/0	.380	.435	.310	.400
4/0	.410	.485	.380	.479

TABLE LIX

"T" Dimensions for Burndy ALUMINUM Flag Type Terminal Lugs

"T" Dimensions (in inches)

AL Wire Size	Using Burndy Tool No. MY28-4		Using Burndy Tools No. Y29B, Y29NC, Y29NSC	
	Min.	Max.	Min	Max.
8	.145	.200	.155	.185
6	.205	.245	.190	.220
4	.265	.305	.260	.290
2	.272	.305	.230	.280
1	.338	.373	.255	.305
1/0	.391	.423	.255	.315
2/0	.370	.406	.345	.405

5–64. TESTS. Sample connections must be tested by an authorized Air Force or Navy laboratory in accordance with the applicable military specifications to check the effectiveness of crimping tools. This should be done periodically.

SECTION VI

THERMOCOUPLE WIRE SOLDERING AND INSTALLATION

6-1. INTRODUCTION

6-2. SCOPE. This section describes and illustrates recommended procedures for fabrication and installation of thermocouple extension leads.

6-3. GENERAL. Thermocouples are used throughout the aircraft to detect and measure temperature changes. Thermocouples are prefabricated into spark plug gaskets, bayonets for insertion into oil sumps and probes for use in exhaust stacks. These thermocouples are supplied with short leads, usually 12 inches long, and end in terminals such as AN-5548 or AN-5539. The installation mechanic fabricates extension leads to carry the voltages generated by the thermocouple to the indicating instruments. The components of a thermocouple system are designed to have a high degree of accuracy; correct installation by a good mechanic will maintain this accuracy.

6-4. The importance of good workmanship in the fabrication and installation of thermocouple wires cannot be over-emphasized. A good mechanic is careful to be neat and thorough in soldering and installing wires.

6-5. REFERENCE SPECIFICATIONS AND DRAWINGS.

Federal Specifications

QQ-S-561	Solder, Silver
QQ-S-571	Solder; Soft (Tin, Tin-Lead, and Lead-Silver)

MIL & JAN Specifications

MIL-T-713	Twine, Lacing and Tying, Electrical and Electronic Equipment
MIL-F-4483	Flux, Brazing, Silver Alloy
MIL-W-5088	Wiring, Aircraft, Installation of
MIL-T-5679	Thermocouple System; Iron-Constantan and Chromel-Alumel, Installation Specification for
MIL-W-5845	Wire, Electrical, Iron and Constantan, Thermocouple
MIL-W-5846	Wire, Electrical, Chromel and/or Alumel, Thermocouple
MIL-S-6872	Soldering Process, General Specification for

Navy Department Specifications

51F1	Flux, Soldering (Paste)
51F4	Flux, Brazing (Silver)

U.S. Army Specifications

2-89-A	Flux - Soft Soldering

Drawings

AN 5537	Connector Assembly–Thermocouple Lead
AN 5538	Terminal – Thermocouple Lead Soldering
AN 5539	Terminal – Thermocouple, Brass
AN 5542	Terminal – Thermocouple
AN 5548	Terminal – Lug, Thermocouple, Chromel and Alumel
AND 10406	Thermocouple Leads – Iron-Constantan, Installation of
AND 10408	Thermocouple Leads – Chromel and Alumel, Installation of

6-6. DESCRIPTION. THERMOCOUPLE WIRE LEADS. See Figure 6-1. Thermocouple extension wires are paired in a braided jacket and color-marked as listed in Table LX. The materials for extension leads is the same as the thermocouple material. Iron-constantan extensions are used for iron-constantan thermocouples and chromel-alumel extensions are used for chromel-alumel thermocouples.

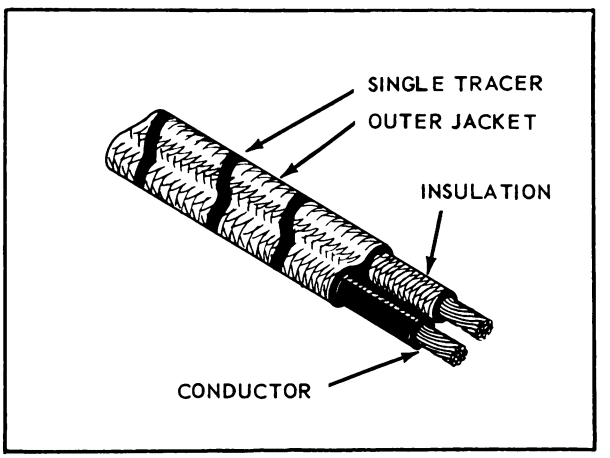


Figure 6–1. Thermocouple Wire

6-7. DESCRIPTION – THERMOCOUPLE TERMINALS AND CONNECTOR. See Figure 6-2. Selection of terminals for thermocouple wiring is governed by AND Drawings 10406 and 10408. The selection is based on location within the airframe, and on temperature conditions. Hot areas are those subject to high temperature, such as engine section, exhaust pipe, etc. Cool areas are those on the side of the firewall away from the engine or other heat producing elements. Where the temperature does not exceed 250° F use terminals listed in Table LXI (derived from AND Drawings 10406 and 10408).

TABLE LX

Thermocouple Systems

a. Iron-Constantan System

Conductor	*Insulation Color*	*Polarity*
Iron	Black	Positive (+)
Constantan	Yellow	Negative (–)

	Type II – 8 ohms per 100 feet		*Type III – 8 ohms per 200 feet*	
	Class A	*Class B*	*Class A*	*Class B*
Outer jacket base color	Light blue	Light blue	Light Blue	Light Blue
Tracer color	None	One red	Two black	Two red
Temperature limit of insulation	120°C (248°F)	230°C (446°F)	120°C (248°F)	230°C (446°F)

b. Chromel-Alumel System

Conductor	*Insulation Color*	*Polarity*
Chromel	White	Positive (+)
Alumel	Green	Negative (–)

	Type II, Class A 7 ohms per 25 ft.	*Type III, Class A 7 ohms per 50 ft.*	*Type IV, Class A 7 ohms per 100 ft.*
Outer jacket base color	White	White	White
Tracer color	One green	Two green	Three green
Temperature limit of insulation	315°C (600°F)	315°C (600°F)	315°C (600°F)

CAUTION

Do not use solderless terminals on thermocouple wire.

Thermocouple connector AN 5537 as shown in Figure 6-3 is used to carry thermocouple connections through firewalls. This is a plug and jack connection, supplied with an insulating plate for attachment to the firewall. Plugs and jacks are supplied in chromel-alumel or iron-constantan combinations. The jack part of the connector is installed on the cool side of the firewall. The pin plug part of the connector is installed on the hot side of the firewall.

6-8. DESCRIPTION – THERMOCOUPLE CONTACTS IN AN CONNECTORS. AN type connectors may be supplied with iron-constantan or chromel-alumel contacts in sizes #12, #16 or #20 in some insert arrangements for thermocouple connections. These contacts are coded to identify the material.

TABLE LXI

Thermocouple Terminals

	Hot Areas (Silver Soldered)	*Cool Areas (Tin-lead Soldered)*
Iron-constantan	AN 5539	AN 5538
Chromel-Alumel	AN 5548	AN 5538

Dash letters after basic numbers indicate whether terminal is plain, or lock type, except for AN 5538, where dash number indicates change in size only.

6-9. DEFINITIONS.

a. Soft solder. A mixture of 60% tin and 40% lead, as specified in Federal Specification QQ-S-571. It may be in bar form to be melted for tinning, or in the form rosin core solder wire for use with soldering iron.

b. Hard solder. Silver alloy with flow point at approximately 635°C (1175°F), as specified in Federal Specification QQ-S-561.

c. Soft solder flux (Army Specification 2-89-A). For use with soft solder, flux is pure water-white rosin (Federal Specification LLL-R-626), if necessary powdered and mixed to a paste-like consistency with denatured alcohol. Other, more active soldering fluxes may be necessary. See paragraph 6-26 for details.

d. Hard solder flux. For use with hard solder, flux is borax or other similar material (MIL-F-4483) (NAVY 51F4) mixed to a paste-like consistency with water.

e. Soldering and brazing. For purposes of this section, the term "soldering" includes soft soldering, silver (hard) soldering and brazing.

6-10. THERMOCOUPLE WIRE PREPARATION.

6-11. CUTTING AND IDENTIFYING THERMOCOUPLE WIRE. Cut thermocouple wire with diagonal pliers to length specified in drawing. Cut so that end is clean and square. Identify wire with sleeves as described in Section II, paragraph 2-24. If outer covering is removed more than three inches from termination, install sleeve just back of serving at branching point, (refer to paragraph 6-24.)

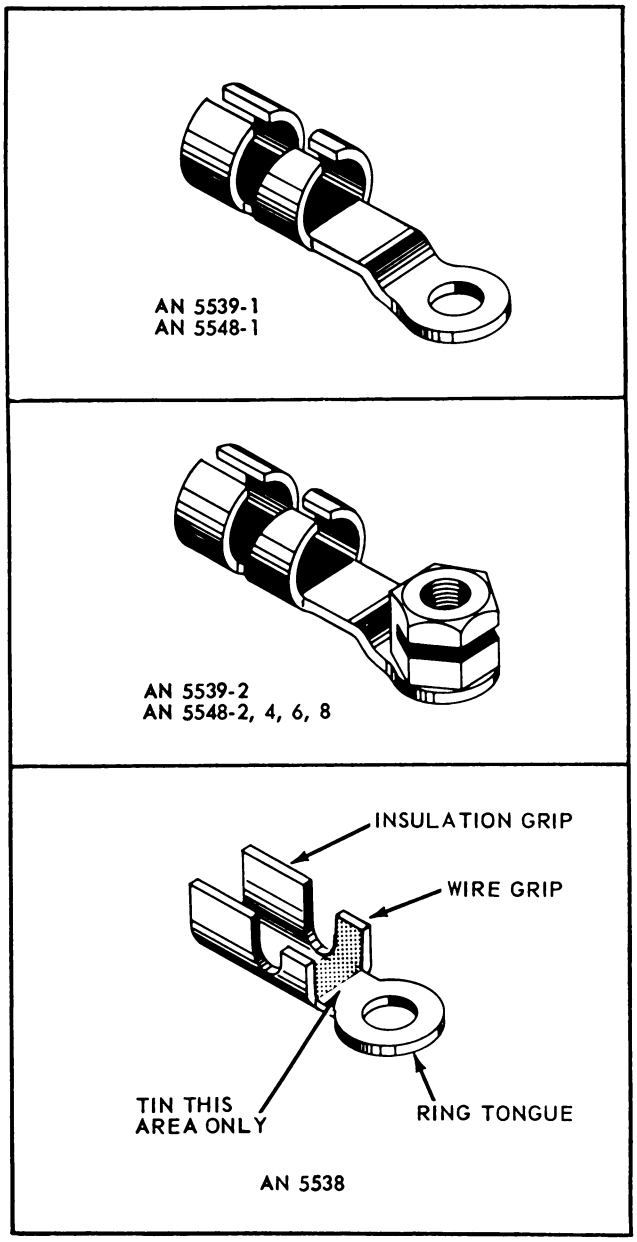


Figure 6–2. Thermocouple Terminals

6-12. STRIPPING THERMOCOUPLE WIRE. Remove outer covering of thermocouple wire with a knife by slitting between parallel conductors and trimming the fabric braid with scissors or diagonal pliers. The stripping dimensions for each use are shown in Figures 6-4 through 6-6. Note that longer stripped lengths are required if the wires are to be resistance tinned.

6-13. Use a hand stripper as illustrated in Section II, Figure 2-20, for removing the primary insulation from each conductor.

CAUTION

Do not cut or nick strands of the conductor.

6-14. CLEANING WIRE PRIOR TO SOLDERING. Clean stripped conductor, if necessary, as follows: Remove grease and dirt by washing with Stoddard solvent. Rinse in methylene chloride for no longer than 5 seconds.

CAUTION

Extra heat and special fluxes are not a safe substitute for clean soldering surfaces.

6-15. HARD SOLDERING.

6-16. TORCH TINNING WITH SILVER SOLDER. Before wires are soldered to terminals or other connections they are tinned. The inability to obtain a good tinned surface indicates that the wire was not clean. The procedure for torch tinning is as follows: See Figure 6-7.

a. Dip half of exposed, clean conductor into hard solder flux.

b. Protect wire insulation with notched copper sheet shield, to prevent scorching.

c. Apply flame to wire until flux bubbles. Then feed small amount of silver solder in wire form to fluxed area while flame is kept there. After the silver solder has flowed remove the flame and allow the wire to cool in air.

CAUTION

Silver solder will flow and adhere to con- approximately 635°C (1175°F). Avoid greater heat than necessary. Excess heat will decompose flux and prevent alloying of silver solder to the wire.

6-17. DIP TINNING WIRE WITH SILVER SOLDER. Thermocouple wires can be dip tinned in molten silver solder if a solder pot capable of maintaining the required 635°C (1175°F) heat is available. The process is similar to that used in dip tinning copper wire in soft solder as described in Section II, paragraph 2-51. The procedure for dip tinning with silver solder is as follows: See Figure 6-8.

a. Dip half of exposed, clean conductor into hard solder flux.

b. Dip fluxed conductor into solder pot. Do not dip conductor deeper than one half of exposed area.

NOTE

Powdered borax sprinkled over top of molten solder will retard oxidation of solder and aid alloying of silver solder to the wire.

c. After solder has flowed between strands, remove the wire and allow it to cool in air.

6-18. RESISTANCE TINNING WIRE WITH SILVER SOLDER. Electrical resistance heat is a good method for silver soldering thermocouple wires. Use a unit which has a capacity of 1000 watts. See Figure 6-9. Wire which is to be tinned by means of electrical resistance should be stripped 1/2 inch longer than wire

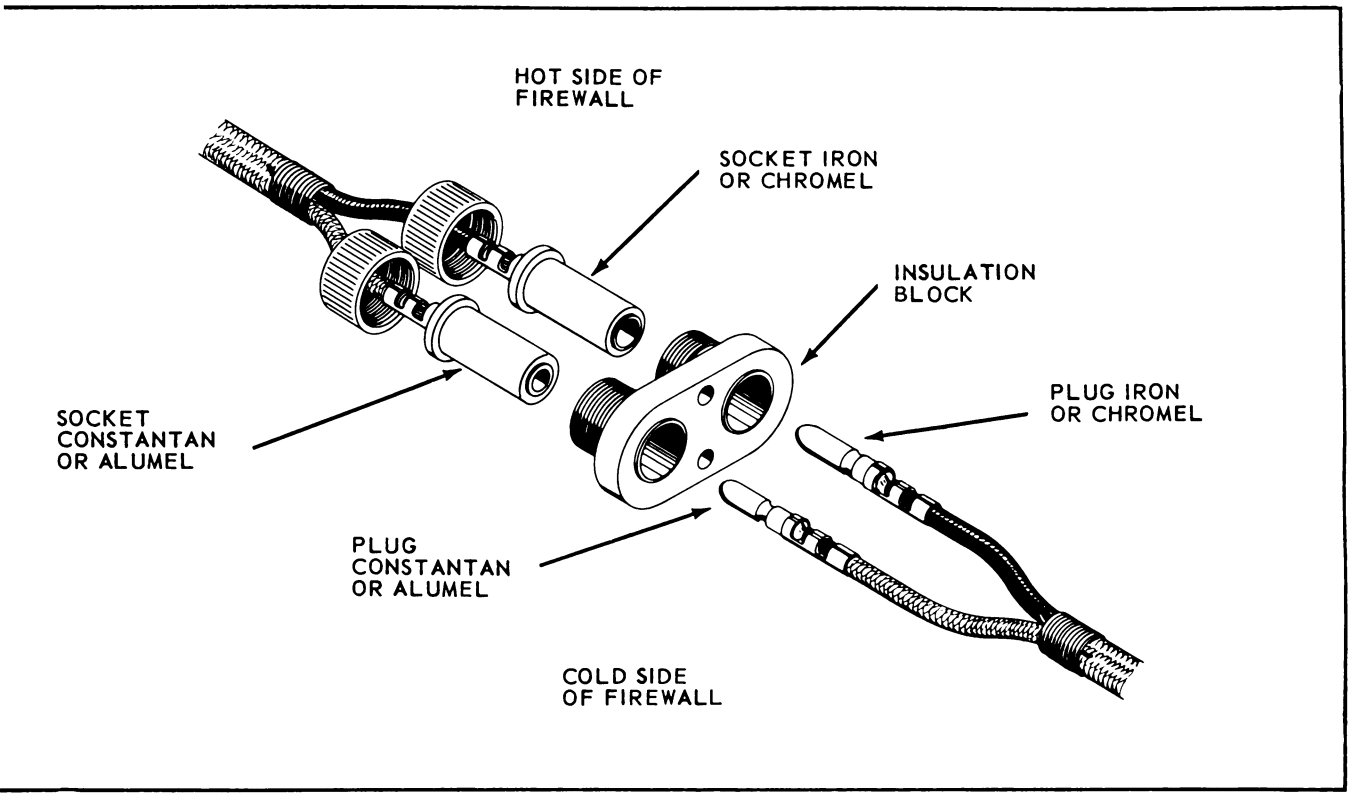


Figure 6–3. Thermocouple Connector Assembly (AN 5537)

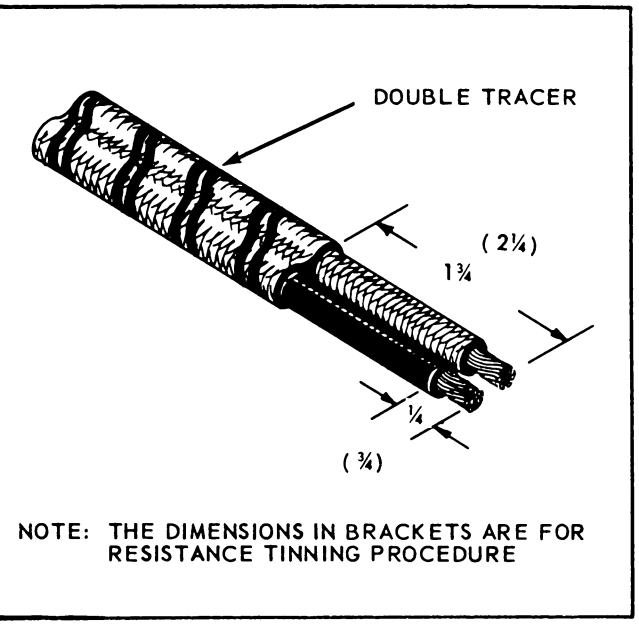


Figure 6–4. Stripping Thermocouple Wire For Terminal & For AN 5537 Connector Installation

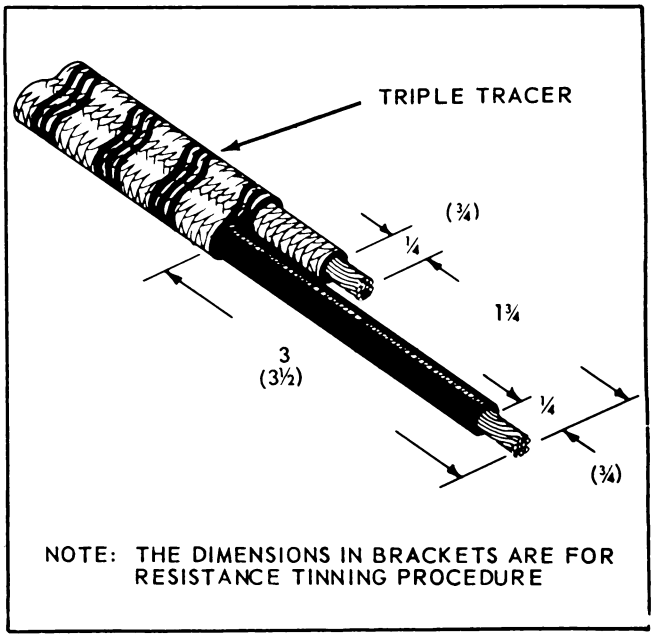


Figure 6–5. Stripping Thermocouple Wire for Splice Installation

which is to be dip tinned or torch tinned. The extra 1/2 inch provides a holding area which is removed after tinning is complete. See Figures 6-4 through 6-6 for stripping dimensions. The procedure for resistance tinning is as follows:

a. Apply hard solder flux to area to be tinned. This is an area about 1/8 inch long as shown in figure.

b. Grasp end of wire in resistance heating pliers. Grasp wire only as shown.

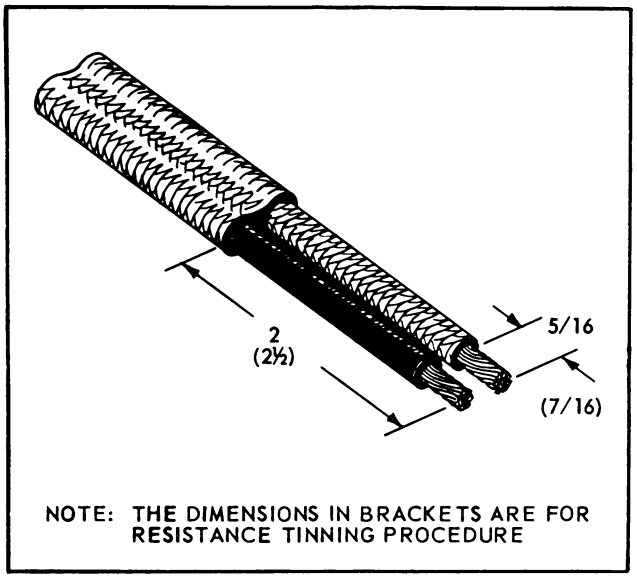


Figure 6–6. Stripping Thermocouple Wire for AN Connector Installation

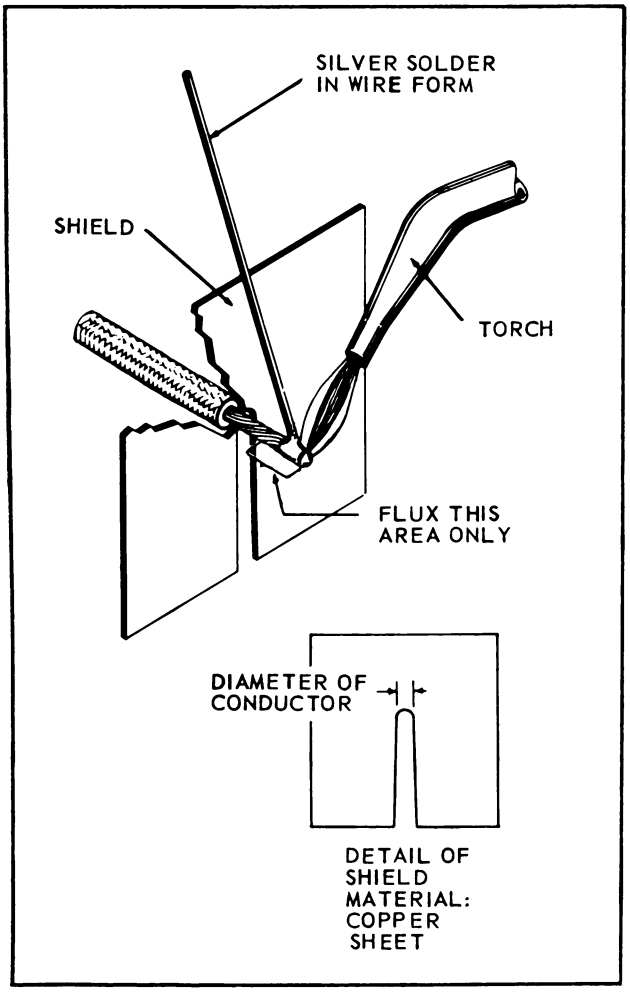


Figure 6–7. Torch Tinning Thermocouple Wire

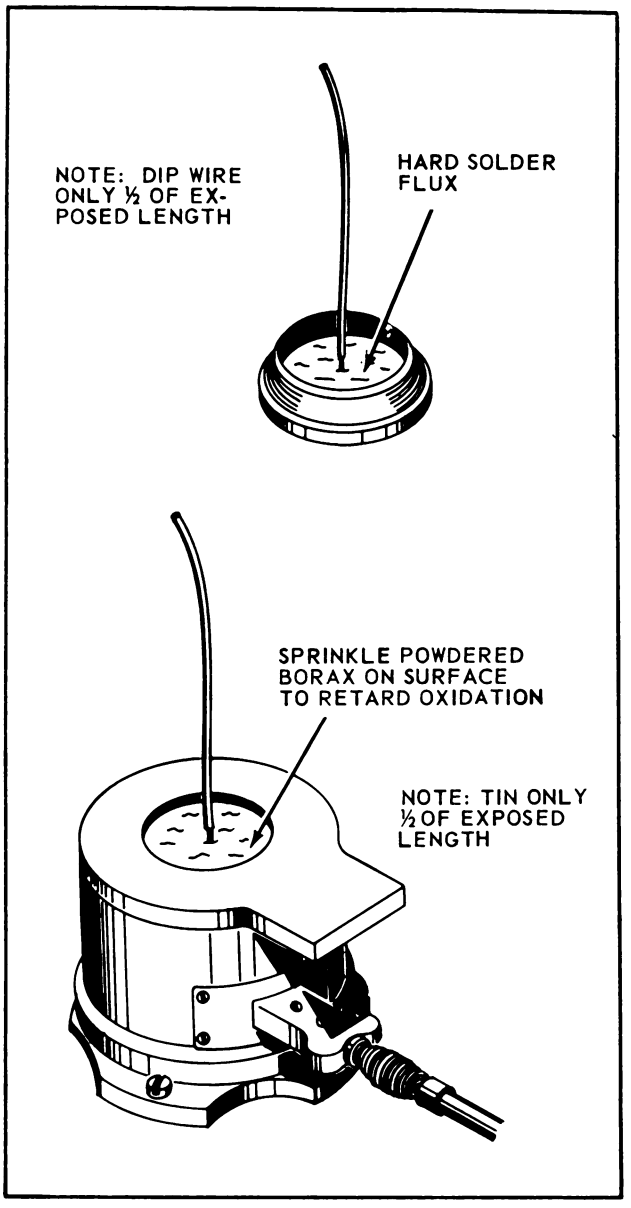


Figure 6–8. Dip Tinning Thermocouple Wire in Silver Solder

c. Apply current for approximately five seconds and then touch silver solder wire to area previously fluxed.

d. After solder has flowed between strands, stop the current and allow the wire to cool in air.

CAUTION

Do not overheat the wire by allowing the current to remain on longer than necessary to flow the silver solder.

e. Trim off the holding area of the exposed conductor. The conductor should be trimmed with diagonal pliers to the point of tinning.

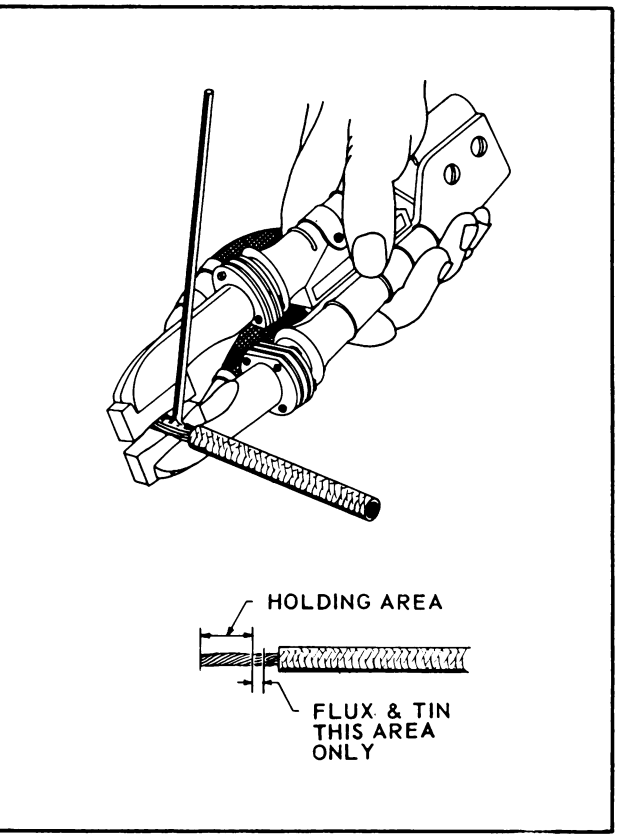


Figure 6–9. Resistance Heating to Tin Wire

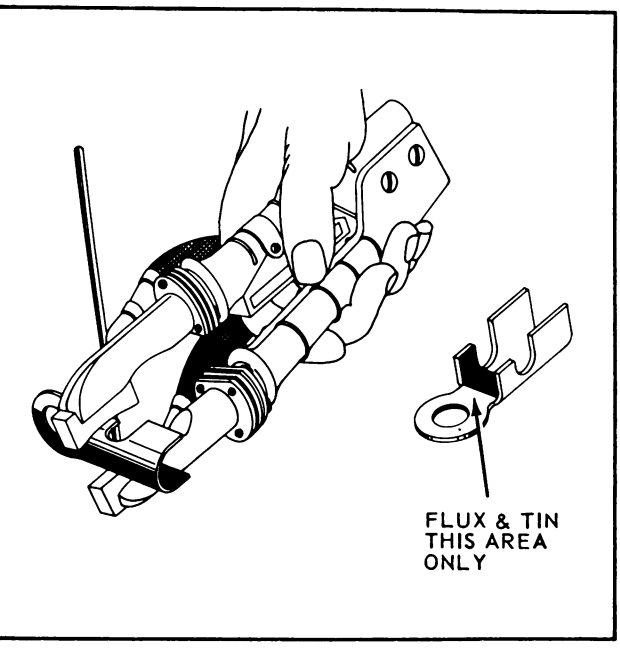


Figure 6–10. Resistance Tinning of Terminal

-19. TINNING TERMINALS WITH SILVER SOLDER. Only tin section of thermocouple terminals inside wire grip as shown in Figure 6-2. Terminals for silver soldering should not be plated.

CAUTION

Do not allow any flux or solder to get on the insulation grip or on the ring tongue.

a. With a brush, apply a small amount of hard solder flux to the area to be tinned.

b. Using a torch or the resistance heating pliers, melt a thin coat of silver solder onto inside of wire grip. See Figure 6-10 for use of resistance heating pliers in this operation.

c. Allow terminal to cool in air.

6-20. PROCEDURE FOR ATTACHING TERMINALS TO THERMOCOUPLE WIRE. Secure terminal to thermocouple wire as follows:

a. Flux previously tinned areas of terminal and wire.

b. Install terminal on wire so that insulation is flush with or protrudes slightly beyond insulation grip. The tinned portion of the conductor should then be inside the wire grip. See Figure 6-11.

c. Crimp wire grip over conductor using modified crimping tool illustrated in Figure 6-12.

NOTE

Do *not* crimp insulation grip until after soldering operation. The heat of soldering may damage insulation if insulation grip is tight during soldering.

6-21. TORCH SOLDERING TERMINALS TO THERMOCOUPLE WIRE. See Figure 6-11.

a. Use copper shield to protect insulation.

b. Heat joint until flux bubbles and then apply silver solder wire to joint as shown. Keep flame in motion to assure uniform heating.

c. When solder has flowed down into wire grip, remove flame and allow joint to cool without disturbing it. Note that AN 5539 terminals require reinforcement with silver solder at indicated areas. See Figure 6-13.

CAUTION

Do not allow solder to flow onto ring tongue as this will prevent proper assembly into system.

6-22. RESISTANCE SOLDERING TERMINALS TO THERMOCOUPLE WIRE.

a. Grasp terminal and wire assembly, prepared in accordance with paragraph 6-20, at wire grip area. The resistance heating pliers are to be in same position as shown in Figure 6-10.

b. Apply current until flux bubbles then add silver solder wire to connection from conductor end of assembly.

c. Continue to apply heat and watch for flow of solder inside wire grip. When solder is visible at opposite end of wire grip from where it was applied, turn off current.

d. Allow assembly to solidify before removing from pliers.

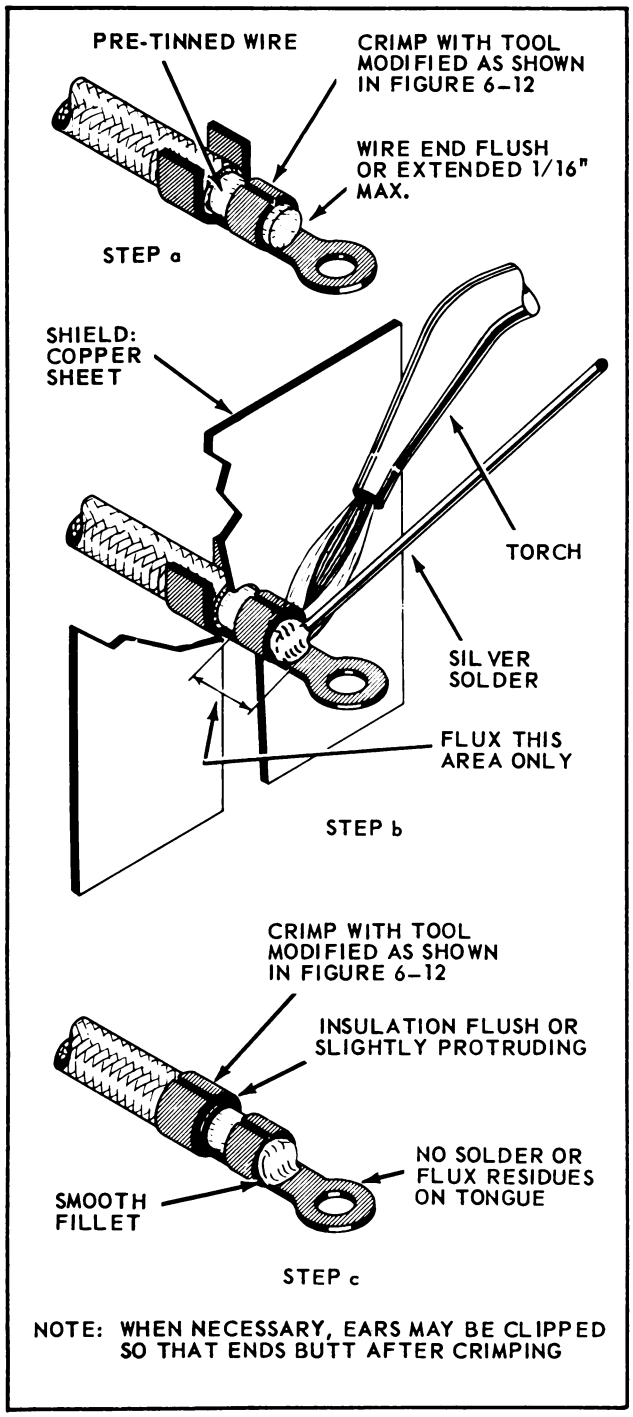


Figure 6–11. Silver Soldering Thermocouple Wire To Terminal

6-23. CLEANING AND COMPLETING SILVER SOLDERED TERMINAL CONNECTIONS. After the silver solder has solidified and cooled, the junction must be completed as follows:

a. Remove flux residues with warm water and a bristle brush, and then dry thoroughly.

b. Secure insulation grip on insulation using modified crimping tool shown in Figure 6-12. The final result is shown in Figure 6-11 step c.

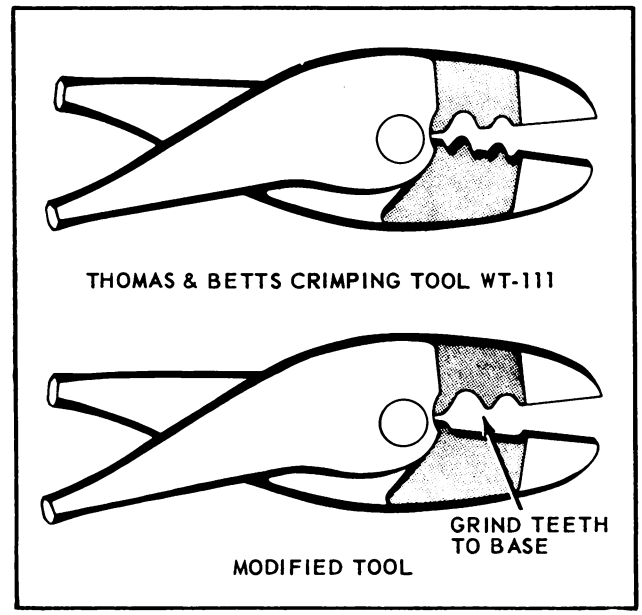


Figure 6–12. Modified Crimping Tool for Thermocouple Terminals

NOTE

Insulation grip ears may be trimmed so they butt.

c. Examine junction to be sure that silver solder has alloyed to wire and terminal. Examine also to be sure that insulation has not been scorched. Rework any connection that is defective.

d. Coat areas indicated in Figure 6-14 with zinc chromate brushing compound.

e. Serve the completed extension lead at branching point as described in paragraph 6-24, and shown in Figure 6-14.

6-24. SERVING THERMOCOUPLE WIRE. After soldering operation has been completed, and solder has cooled, serve thermocouples at the branching point as shown in Figure 6-11. Use nylon or waxed cotton cord in cool areas, and fiberglass cord in hot areas. Coat the serving with clear lacquer. The serving will prevent unraveling of the outer jacket.

6-25. SOFT SOLDERING.

6-26. TINNING WIRE FOR SOFT SOLDERING. Tin thermocouple wires for soft soldering in the same manner as copper wire as described in Section II, Paragraphs 2-47 through 2-53. Either dip tinning or soldering iron tinning is satisfactory. Occasionally, if wires are oxidized, rosin-alcohol flux may not do a satisfactory job of tinning; if this happens use the following:

Lactic acid-glycerin-rosin mixture made by mixing (by weight) one part of lactic acid (C.P.) with one part glycerin (U.S.P.), and adding three parts pure, freshly powdered rosin.

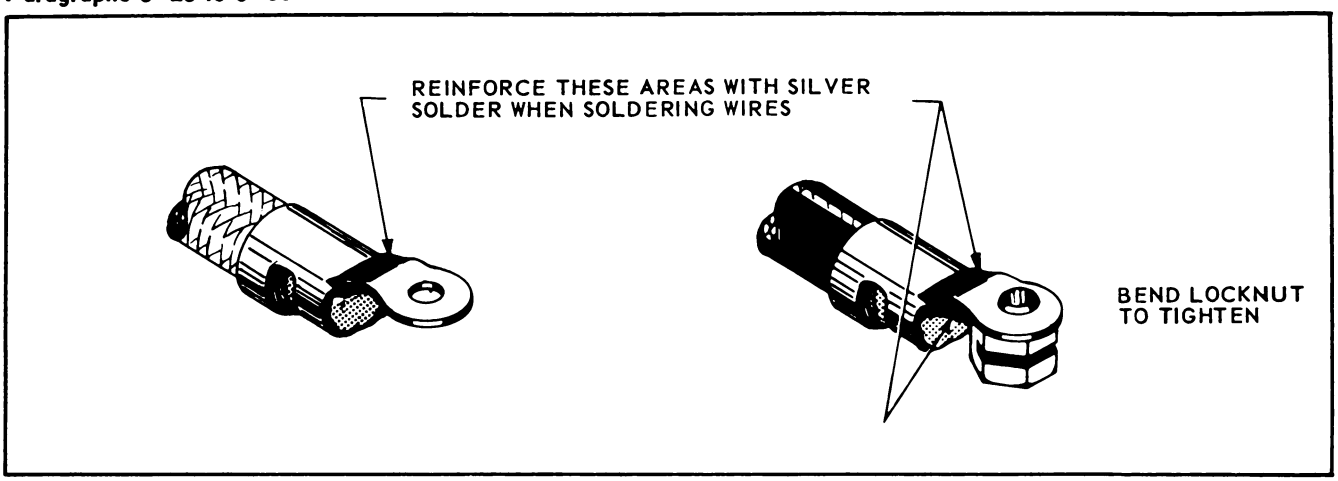


Figure 6–13. Reinforcing Solder on "AN" 5539 Terminals

NOTE

When soldering-iron method is used, use a soldering iron of 200 to 250 watts capacity for tinning thermocouple wires.

6-27. TINNING TERMINALS FOR SOFT SOLDERING. Tin terminal section inside wire grip, using 200 to 250 watt solder-iron, and rosin core solder, if possible. Do not allow flux or solder to get on the insulation grip or on the ring part of the tongue.

NOTE

Terminals for use with soft solder should be cadmium plated.

6-28. PROCEDURE FOR SOFT - SOLDERING WIRE TO TERMINALS.

a. Install terminals on thermocouple wires as described in paragraph 6-20, and illustrated in Figure 6-11 step a.

b. Soft solder, using 200 to 250 watt iron and rosin core solder. Make sure that solder flows inside wire grip and forms a smooth fillet.

CAUTION

For soft-soldering, do not use any flux other than rosin-alcohol, regardless of flux used for tinning.

c. Remove excess flux by scrubbing with brush and denatured alcohol.

d. Bend insulation grip ears around insulation using modified crimping tool shown in Figure 6-12. Trim ears so they butt flush around small wires. See Figure 6-11 step c.

e. Coat areas indicated in Figure 6-14 with zinc chromate brushing compound.

6-29. PROCEDURE FOR SOLDERING WIRE TO AN SERIES CONNECTORS. Thermocouple contacts in AN series connectors are not tinned by the manufacturer. Therefor it is necessary to properly tin these contacts with soft solder before thermocouple wire is soft soldered into place. AN connector contacts must be removed from inserts for soldering because of the extra heat needed to raise thermocouple wire to solder temperature. Best results are obtained when electrical resistance heating pliers are used to tin the contact and also for soldering wire into contact. The procedure for tinning and soldering is as follows:

a. Tin contact by use of resistance heating pliers or torch. Use rosin-alcohol flux and 60/40 tin-lead solder or, if necessary use flux described in paragraph 6-26, with the same 60/40 tin-lead solder.

b. Remove flux residues. Rosin residues are moved by brushing vigorously with Stoddard's Solvent or with denatured alcohol. Lactic acid flux is removed by brushing in warm water. Dry each tinned contact thoroughly before proceeding with next step.

c. Check contact coding and wire coding carefully to avoid mismatch of materials. See Tables LX and LXII of this section.

d. Insert proper pretinned wire into contact and solder using resistance pliers or torch. Use only rosin core solder for this operation. See Figure 6-15.

e. After solder has flowed and alloyed, allow connection to cool without motion. Then remove flux residues with Stoddard's Solvent or denatured alcohol.

f. Examine joint to be sure solder has flowed to form smooth fillet, and that no solder is left on outside of solder cup.

CAUTION

It is important that thermocouple materials match. Iron wire must be soldered to iron contacts and constantan wire to constantan contacts.

g. Reassemble contacts into AN connector as described in Section III, paragraphs 3-47 through 3-66. Be careful to reassemble each contact into the hole from which it was removed.

6-30. PROCEDURE FOR SOLDERING WIRE TO AN 5537 FIREWALL CONNECTOR. Thermocouple wires are brought through firewalls by means of AN 5537 firewall connectors. To preserve the integrity of the system, it is necessary to hard solder wires to the connector on the hot side of the firewall. The cool side of the firewall may be either hard or soft soldered.

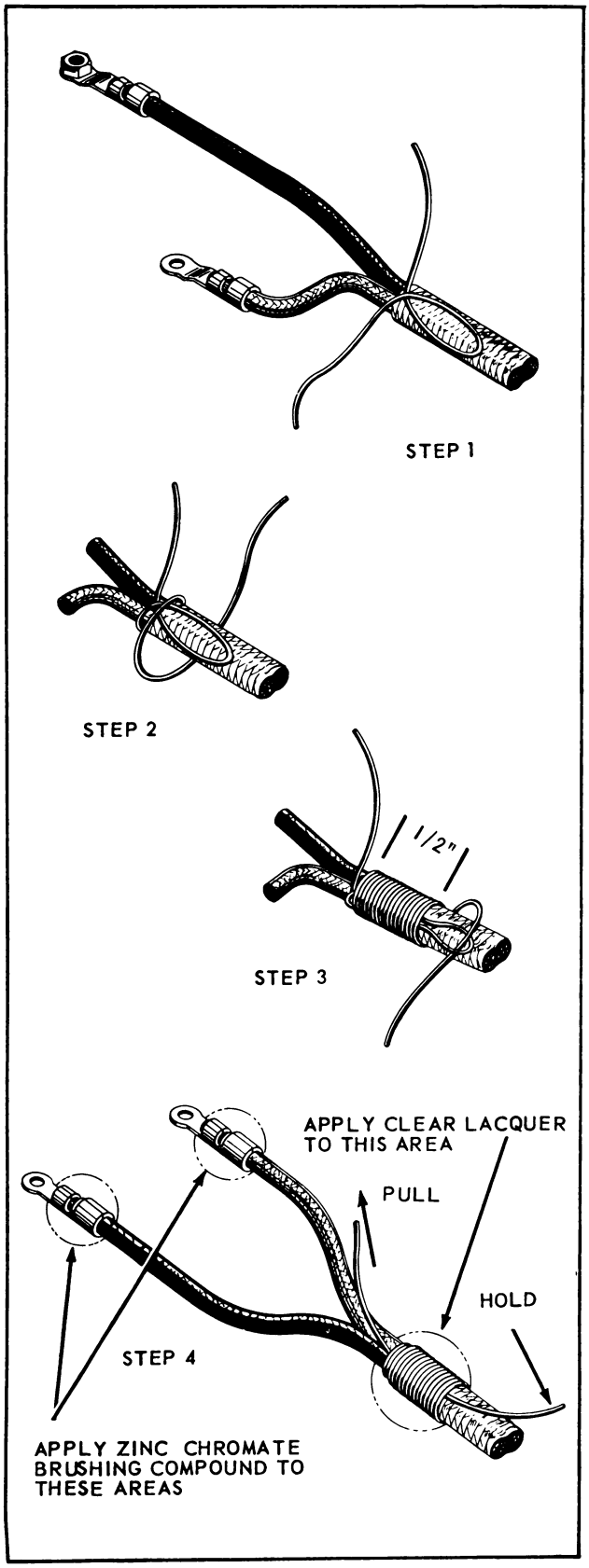


Figure 6–14. Serving Thermocouple Wire

CAUTION

Be careful to connect wire leads to mating materials of connector. Connector plugs and sockets are coded with letters to indicate materials. Sizes are also different to aid in quick identification.

The procedure for attaching wires is as follows: See Figure 6-3.

a. Disassemble connector as shown. Slide nuts over the pretinned leads which will be installed on the hot side of the firewall.

b. Tin the wire grips of the socket assemblies using hard solder as described in paragraph 6-19.

TABLE LXII

Coding for Thermocouple Contacts in AN Type Connectors

Manufacturer	*Method of Coding*	*Code* *Iron*	*Constantan*	*Chromel*	*Alumel*
Amphenol	Color	White	Red	Green	Orange
Bendix	Color	Black	Yellow	White	Green
Cannon	Letters	IR	CO	CH	AL

TABLE LXIII

Code for markings on AN 5537

Material	*Code*	*Size*
Iron	FE	Large
Constantan	CON	Small
Chromel	CR	Large
Alumel	AL	Small

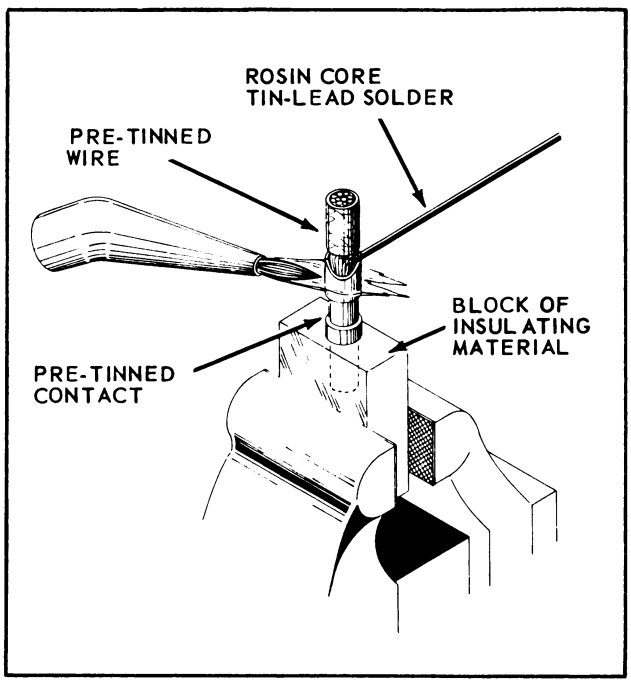


Figure 6–15. Torch Soldering Thermocouple Wire to "AN" Connector Contact

c. Assemble and hard solder wires to socket assemblies as described in paragraphs 6-20 through 6-22.

d. Complete assembly of hot side wires by cleaning, crimping insulation grips and coating with zinc chromate brushing compound as described in paragraph 6-23.

e. Attach plugs to wires on cold side of firewall by using hard or soft solder as required on applicable drawing for the specific installation. The method of attachment, soldering, cleaning, etc., is the same as that previously described.

6-31. THERMOCOUPLE WIRING INSTALLATION.

6-32. CONNECTING THERMOCOUPLE SPLICES. See Figure 6-16. Connect thermocouple splices as follows:

a. Slide sleeve over one lead.

b. Bend locknut of lock terminal slightly before assembly to assure tightness.

c. Bring contact areas of two terminals together, and pass screw through plain terminal first and then through locknut of lock terminal.

d. Tighten screw securely.

e. Slide sleeve over terminal and tie securely.

6-33. MOUNTING AN 5537 CONNECTOR ASSEMBLY. AN 5537 firewall connector assemblies are mounted as follows: See Figure 6-3.

a. Attach insulating block to firewall on hot side. Bosses on block should fit into holes in firewall so that block face is flush against wall.

b. Push socket assemblies through holes and lock into place with coupling nuts.

c. Push plugs into socket assemblies from cold side of firewall.

6-34. ROUTING THERMOCOUPLE WIRING. Route thermocouple wiring as described generally in Section XI. In addition observe the following special precautions:

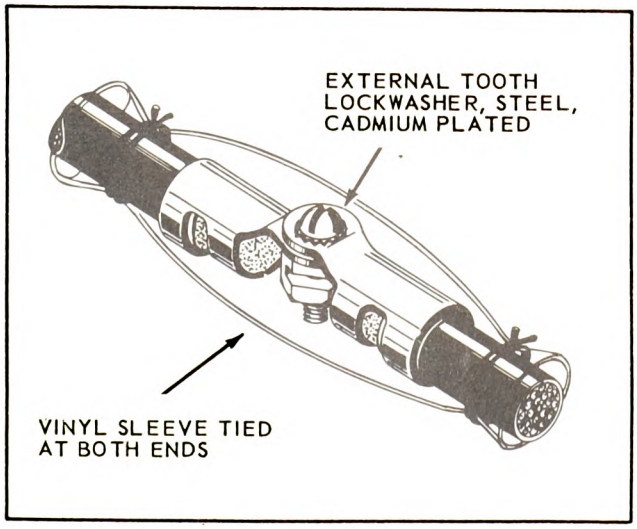


Figure 6–16. Connecting Thermocouple Splices

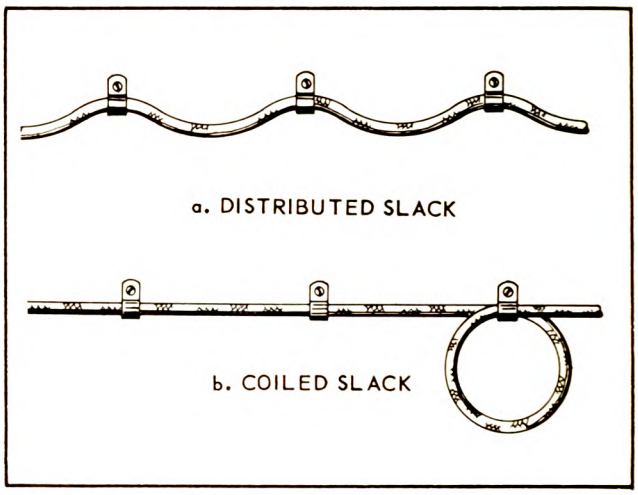


Figure 6–17. Distributing Slack in Thermocouple Wire

a. Support thermocouple wiring so it will not come into contact with heat producing surfaces such as exhaust pipe or combustion chamber at any point.

b. Do not bend thermocouple leads sharply.

c. Do not splice thermocouple leads except where specifically indicated and then only with approved splices such as shown in Figure 6-16.

d. Protect adjacent wiring against abrasion from thermocouple splices as described in paragraph 6-35.

6-35. PROTECTION. Insulate thermocouple spliced terminal connections with sleeves to protect the insulation of adjacent wires from abrasion. Use plastic sleeving in cool areas, and silicone impregnated rubber or glass sleeving in hot areas. Tie sleeving securely at both ends.

CAUTION

Do not use sleeving as a substitute for safe routing.

6-36. SLACK IN THERMOCOUPLE WIRING. See Figure 6-17. Thermocouple wire installations require the use of fixed wire lengths to maintain a specified resistance. The slack that results should be distributed by one of the following methods:

a. Distribute excess slack evenly between wire supports, as shown in Figure 6-17a.

b. If sufficient slack is available, take it up, at a support, in the form of a loop of which the diameter is at least 20 times the thickness of the thermocouple wire, as shown in Figure 6-17b.

CAUTION

Do not bend thermocouple leads to less than a two inch radius. When calibration resistors are used in the circuit to adjust for short lengths, do not allow any excess slack, except for approximately three inches at each end for maintenance.

SECTION VII

BONDING AND GROUNDING

7–1. INTRODUCTION.

7–2. SCOPE. This section describes and illustrates the recommended procedures to be followed in the preparation and installation of bonding and grounding connections.

7–3. GENERAL. Bonding and grounding connections are made in aircraft for the following purposes:

a. To protect aircraft and personnel against hazards from lightning discharge.
b. To provide power current return paths.
c. To prevent development of RF potentials.
d. To protect personnel from shock hazard.
e. To provide stability and homogeneity of radio transmission and reception.
f. To prevent accumulation of static charge.

7–4. REFERENCE SPECIFICATIONS.

MIL–M–3171	Magnesium Alloys; Processes for Corrosion Prevention of
MIL–B–5087	Bonding, Electrical, for Aircraft
MIL–W–5088	Wiring, Aircraft, Installation of
MIL–T–6094	Thinner; Dope and Lacquer (Cellulose-nitrate)
MIL–P–6889	Primer, Zinc-Chromate, for Aircraft Use

7–5. DEFINITIONS.

a. Bonding is the electrical connecting of two or more conducting objects not otherwise adequately connected.

b. Grounding is the electrical connecting of a conducting object to primary structure, for return of current.

c. Primary structure is the main frame, fuselage and wing structure of the aircraft (commonly referred to as ground).

7–6. GENERAL PROCEDURES AND PRECAUTIONS. When making bonding or grounding connections in aircraft, observe the following general precautions, and procedures:

a. Bond or ground parts to the primary aircraft structure where practicable.

b. Make bonding or grounding connections in such a way as not to weaken any part of the aircraft structure.

c. Bond parts individually wherever possible.

d. Make bonding or grounding connections against smooth, clean surfaces.

e. Install bonding or grounding connections so that vibration, expansion or contraction, or relative movement incident to normal service use will not break or loosen the connection.

f. Locate bonding and grounding connections in protected areas whenever possible; locate connections whenever possible near hand holes, inspection doors or other accessible areas to permit easy inspection and replacement.

g. Do not compression-fasten bonding or grounding connections through any non-metallic material.

7–7. SELECTION OF HARDWARE. Hardware used to make bonding or grounding connections is selected on the basis of mechanical strength, current to be carried and ease of installation. Where connection is made by aluminum or copper jumpers to structure of dissimilar material, a washer of suitable material is installed between the dissimilar metals so that any corrosion which may occur will occur in the washer, which is expendable, rather than in the structure, which is not expendable.

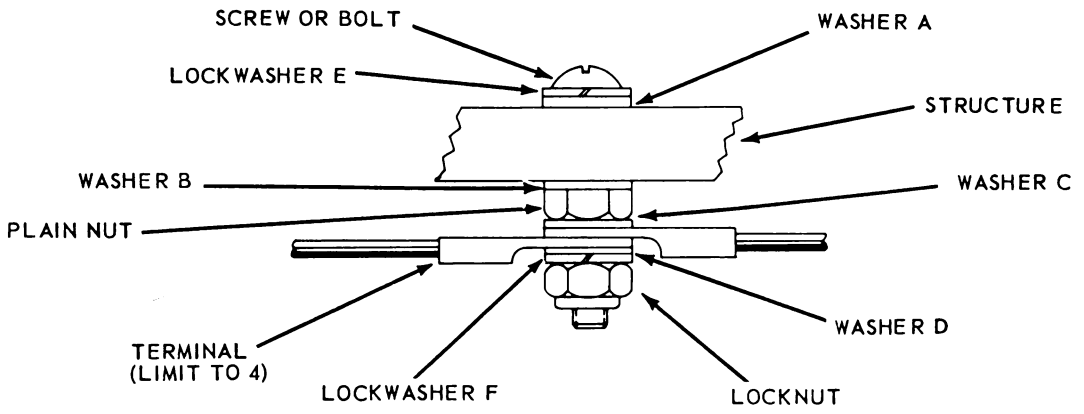
NOTE

When repairing or replacing existing bonding or grounding connections, be sure to use the same type of hardware as in the original connection. Do not make any changes.

7–8. HARDWARE MATERIAL AND FINISH. Select hardware material and finish from Tables LXIV, LXV, LXVI, depending on material of structure to which attachment is made, and material of jumper and terminal specified for the bonding or grounding connection.

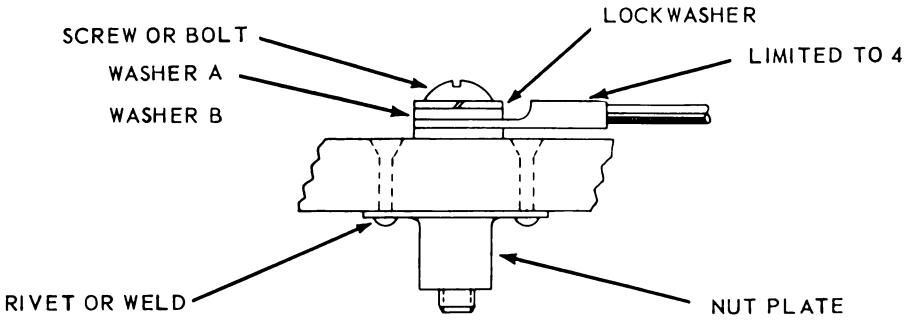
7–9. SELECTION OF STUD. Use either an AN screw or bolt of the proper size for the specified jumper terminal. Length of screw or bolt should be such that when bonding or grounding connection is fully tightened approximately 1/8 inch of screw protrudes beyond top of nut.

7–10. SELECTION OF NUTS. Use AN nuts, either plain or self-locking where indicated in Figures 7–1 and 7–3. Use an *all-metal* self-locking nut if practicable. Always use an all-metal self-locking nut where current is, or will be present. Where installation conditions require, use an AN nut-plate, riveted to structure.



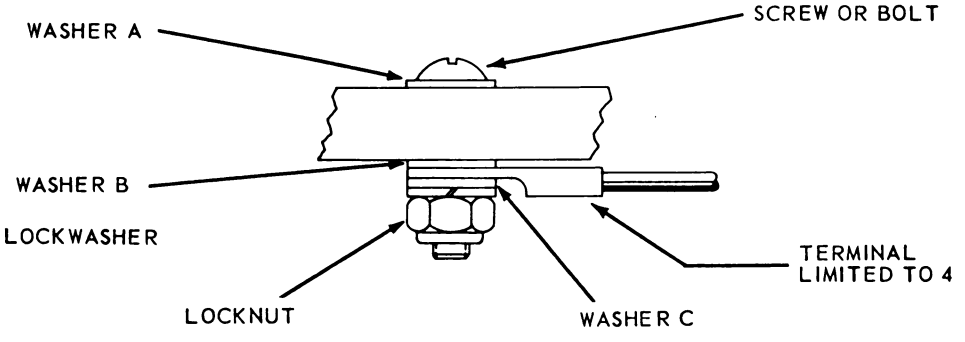
NOTE: SEE TABLE LXIV FOR MATERIALS

Figure 7–1. Stud Bonding or Grounding to Flat Surface



NOTE: SEE TABLE LXV FOR MATERIALS

Figure 7–2. Plate Nut Bonding or Grounding to Flat Surface



NOTE: SEE TABLE XLVI FOR MATERIALS

Figure 7–3. Bolt & Nut Bonding or Grounding to Flat Surface

TABLE LXIV

(Refer to Figure 7–1)

Aluminum Terminal and Jumper

Structure	*Screw or Bolt* / *Lock-Nut*	*Plain Nut*	*Washer A*	*Washer B*	*Washer C & D*	*Lock-Washer E*	*Lock-Washer F*
Aluminum Alloys	Cad. Plated Steel	Cad. Plated Steel	Aluminum Alloy	Aluminum Alloy	Cad. Plated Steel or Aluminum	Cad. Plated Steel	Cad. Plated Steel
Magnesium Alloys	Cad. Plated Steel	Cad. Plated Steel	Magnesium Alloy	Magnesium Alloy	Cad. Plated Steel or Aluminum	Cad. Plated Steel	Cad. Plated Steel
Steel, Cadmium Plated	Cad. Plated Steel	Cad. Plated Steel	None	None	Cad. Plated Steel or Aluminum	Cad. Plated Steel	Cad. Plated Steel
Steel, Corrosion Resisting	Corrosion Resisting Steel	Cad. Plated Steel	None	None	Cad. Plated Steel or Aluminum	Cor. Resist Steel	Cad. Plated Steel

Tinned Copper Terminal and Jumper

Aluminum Alloys	Cad. Plated Steel	Cad. Plated	Aluminum Alloy	Aluminum Alloy	Cad. Plated Steel	Cad. Plated Steel	Cad. Plated Steel or Aluminum
Magnesium Alloys	AVOID CONNECTING COPPER TO MAGNESIUM						
Steel, Cadmium Plated	Cad. Plated Steel	Cad. Plated Steel	None	None	Cad. Plated Steel	Cad. Plated Steel	Cad. Plated Steel
Steel, Corrosion Resisting	Corrosion Resisting Steel	Cor. Res. Steel	None	None	Cad. Plated Steel	Cor. Resist Steel	Cor. Resist Steel

7–11. SELECTION OF WASHERS. Use AN plain washers and split lockwashers where indicated in Figures 7–1, 7–2 and 7–3. Always use split lockwashers with nuts, either plain or self-locking. With aluminum terminals use a plain washer of at least the diameter of the terminal tongue, next to the aluminum terminal. If an AN washer does not meet this requirement, use a washer of the SAE heavy series, or a special washer made for this application.

7–12. SELECTION OF CABLE CLAMP. For bonding or grounding to cylindrical surfaces use an AN 735 clamp. Where an AN 735 clamp is not available, or where installation conditions do not allow its use, an uncushioned AN 742 clamp may be substituted.

CAUTION

Do not use cushioned clamps in any bonding or grounding connection.

7–13. PREPARATION OF BONDING OR GROUNDING SURFACES. Clean bonding and grounding surfaces thoroughly before making the connection. Remove all oil, grease, paint, anodic film or other nonconducting material from an area slightly larger than the connection.

CAUTION

Do not use abrasives such as emery cloth, crocus cloth, steel wool, etc. These may leave particles imbedded in the surface or scattered in the area which may cause corrosive action.

7–14. CLEANING PROCEDURE FOR ALUMINUM SURFACES. Apply a coating of petrolatum compound to bonding or grounding surface of aluminum structure, and clean surface thoroughly, using steel wire brush with pilot as shown in Figure 7–4. Wipe off the petrolatum compound with a clean dry cloth.

7–15. CLEANING PROCEDURE FOR MAGNESIUM ALLOY SURFACES. Prepare magnesium alloy surfaces for bonding or grounding as follows:

a. Remove grease and oil from surface with Stoddard solvent.

b. Remove paint or lacquer, if present, from surface with lacquer thinner (MIL-T-6094).

c. Brush area liberally with chrome pickle solution (MIL-M-3171) for one minute, then rinse within five seconds by brushing with clean water.

d. Dry thoroughly.

TABLE LXV

(Refer to Figure 7–2)

Aluminum Terminal & Jumper

Structure	*Screw or Bolt*	*Nut Plate*	*Rivet*	*Lock Washer*	*Washer A*	*Washer B*
Aluminum Alloys	Cad. Plated Steel		Alum. Alloy	Cadmium Plated steel	Cad. plated steel or aluminum	None
Magnesium Alloys	Cad. Plated Steel		Alum. Alloy	Cadmium Plated steel	Cad. plated steel or aluminum	None or Mag. alloy
Steel, Cadmium plated	Cad. Plated Steel		Cor. Resist Steel	Cadmium Plated Steel	Cad. plated steel or aluminum	None
Steel, Corrosion Resisting	Corrosion Resist. Steel or Cad. Plated Steel		Cor. Resist Steel	Cadmium Plated steel	Cad. plated steel or aluminum	Cad. plated steel

Tinned Copper Terminal & Jumper

Aluminum Alloys	Cad. Plated Steel	Alum. Alloy	Cadmium Plated Steel	Cad. plated steel	Alum Alloy
Magnesium Alloys	Avoid connecting copper to Magnesium				
Steel, Cadmium plated	Cad. Plated Steel	Cor. Resist. Steel	Cadmium Plated Steel	Cad. plated steel	None
Steel, Corrosion Resisting	Corrosion Resist. Steel	Cor. Resist. Steel	Cadmium Plated Steel	Cad. plated steel	None

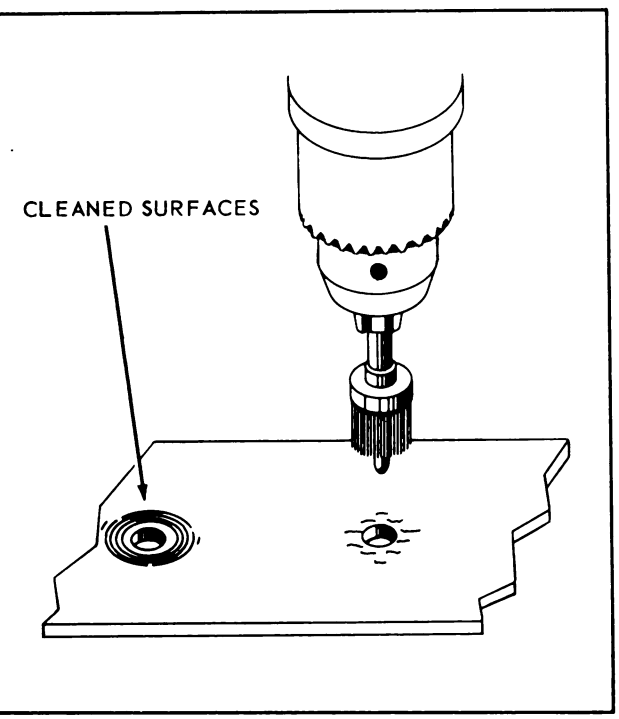


Figure 7–4. Steel Wire Brush with Pilot for Cleaning Aluminum Surfaces

7–16. CLEANING PROCEDURE FOR STEEL SURFACES. When the surface is corrosion-resisting or plated steel, clean bonding or grounding surface as described in paragraph 7–15, steps a and b.

CAUTION

Do not remove zinc or cadmium plate from steel surfaces.

7–17. METHODS OF BONDING OR GROUNDING. Bonding or grounding connections are made directly to a flat surface of basic structure; or to a cylindrical surface of basic structure.

7–18. CONNECTION TO FLAT SURFACES. Bonding and grounding connections are made to flat surfaces by means of through bolts or screws where installation has easy access. There are three types of bolted connection as follows:

a. Stud connection: (See Figure 7-1 and Table LXIV) In this type of connection a bolt or screw is locked securely to structure, thus becoming in effect a stud. Grounding or bonding jumpers can be removed or added to the shank of stud without removing stud from structure.

TABLE LXVI

(Refer to Figure 7-3)

Aluminum Terminal & Jumper

Structure	*Screw or Bolt* / *Nut Plate*	*Lock Washer*	*Washer A*	*Washer B*	*Washer C*
Aluminum Alloy	Cad. Plated Steel	Cad. Plated Steel	Cad. plated steel or aluminum	None	Cad. plated steel or aluminum
Magnesium Alloy	Cad. Plated Steel	Cad. Plated Steel	Magnesium Alloy	None or Mag. Alloy	Cad. plated steel or aluminum
Steel, Cadmium plated	Cad. Plated Steel	Cad. Plated Steel	Cad. Plated Steel	Cad. plated steel	Cad. plated steel or aluminum
Steel, Corrosion Resisting	Corrosion Resisting Steel or Cad. plated steel	Cad. Plated Steel	Corrosion Resisting Steel	Cad. plated steel	Cad. plated steel or aluminum
Tinned Copper Terminal & Jumper					
Aluminum Alloy	Cad. plated steel	Cad. Plated Steel	Cad. plated steel	Alum. alloy	Cad. plated steel
Magnesium Alloy	Avoid connecting copper to Magnesium				
Steel, Cadmium Plated	Cad. plated steel	Cad. Plated Steel	Cad. plated steel	None	Cad. plated steel
Steel, Corrosion Resisting	Corrosion Resisting Steel or Cad. Plated Steel	Cad. Plated Steel	Corrosion Resisting Steel	None	Cad. plated steel

b. Nut plate and bolt connection: (See Figure 7-2 and Table LXV) Nut plates are used where access to the nut for repairs may be difficult. Nut plates are riveted or welded to a clean area of the structure. Cleaning of structure is done in accordance with paragraphs 7-14 through 7-16 as applicable.

c. Nut and bolt connection: (See Figure 7-3 and Table LXVI) In this connection the bolt or screw is not attached permanently to structure. When jumpers are to be added or removed, the entire connection is remade.

The table under each figure lists materials and platings which are compatible with the structure to which they are mounted. These materials are selected so that corrosion, if it occurs, will occur in the washers which are replaceable and not in the airframe which is not expendable.

7-19. CONNECTION TO TAB RIVETED TO STRUCTURE. See Figure 7-5. When a bonding or grounding connection is made to a tab riveted to structure rather than directly to structure, clean the bonding or grounding surface and make the connection exactly as though the connection were being made to structure. If it is necessary to remove the tab for any reason, replace rivets with one size larger. Make sure mating surfaces of structure and tab are clean, and free of anodic film.

7-20. CONNECTION TO CYLINDRICAL SURFACES. Make bonding or grounding connections to aluminum alloy, magnesium alloy or corrosion resisting steel tubular structure as shown in Figure 7-6 and 7-7. Figure 7-6 shows the arrangement of hardware for bonding with an aluminum jumper. Because of the ease with which aluminum is deformed, it is necessary to distribute screw and nut pressure by means of plain washers as shown. Figure 7-7 shows the arrangement of hardware for bonding with a copper jumper. No extra washers are used. If installation conditions require, use AN 724 clamp (uncushioned) instead of AN 735. Do not change any hardware if this substitution is made.

7-21. BONDING CONDUIT TO STRUCTURE. See Figure 7-8. Bond aluminum alloy or corrosion-resisting steel conduit to structure as shown in Figure 7-8. If installation conditions require, AN 742 clamp may be used instead of AN 735, using same hardware.

7–22. TIGHTNESS OF CONNECTIONS. Make sure that all connections are tight as evidenced by the split lock-washers being completely compressed.

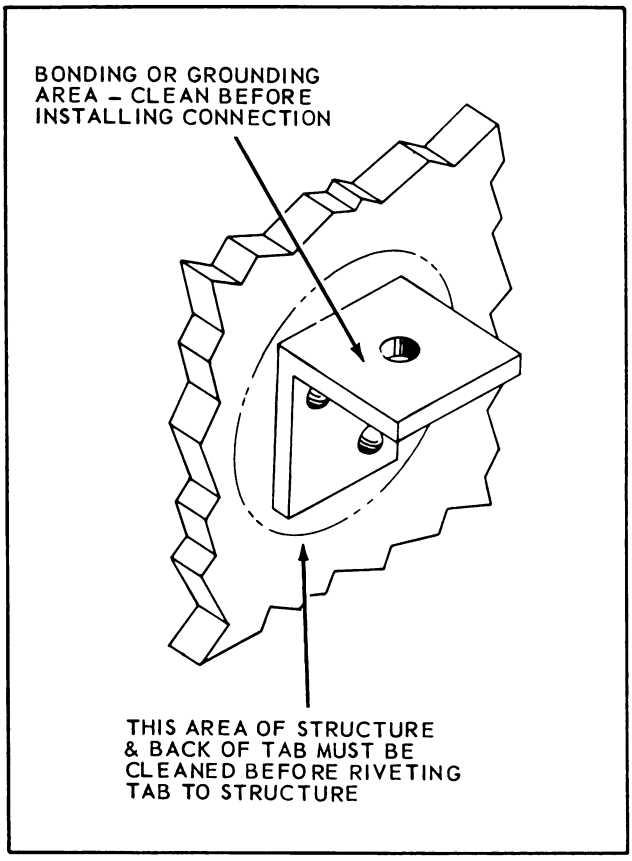


Figure 7–5. Bonding Tab Riveted to Structure

CAUTION

When terminal is under head of screw or bolt (as shown in Figure 7–2), it is preferable not to install more than one terminal. A loose screw with two terminals may cause inadvertant operation of equipment.

7–23. REFINISHING.

7–24. REFINISHING ALUMINUM ALLOY SURFACES. Within one week after any area has been cleaned and connection made, refinish aluminum surfaces as follows:

a. Apply coat of zinc chromate brushing compound, and allow to dry.

b. When thoroughly dried, refinish cleaned area to match original surrounding finish.

7–25. REFINISHING MAGNESIUM ALLOY SURFACES. Within 24 hours after cleaning surface of magnesium alloys, apply a protective coat of zinc chromate brushing compound. Within one week after making and testing the connection, refinish cleaned area to match original surrounding finish.

7–26. REFINISHING STEEL SURFACES. Within one week after connection has been made, refinish cleaned area to match original surrounding finish.

7–27. TESTING BONDS AND GROUNDS.

7–28. TESTS AFTER CONNECTION. Test all bonds and ground connections after connection is made and before refinishing. Bonding resistances are listed in MIL-B-5087 and MIL-W-5088.

7–29. TESTS AFTER REFINISHING. Re-test all bonding and grounding connections after zinc chromate brushing compound has dried thoroughly. If necessary, repair finish which has been damaged during testing.

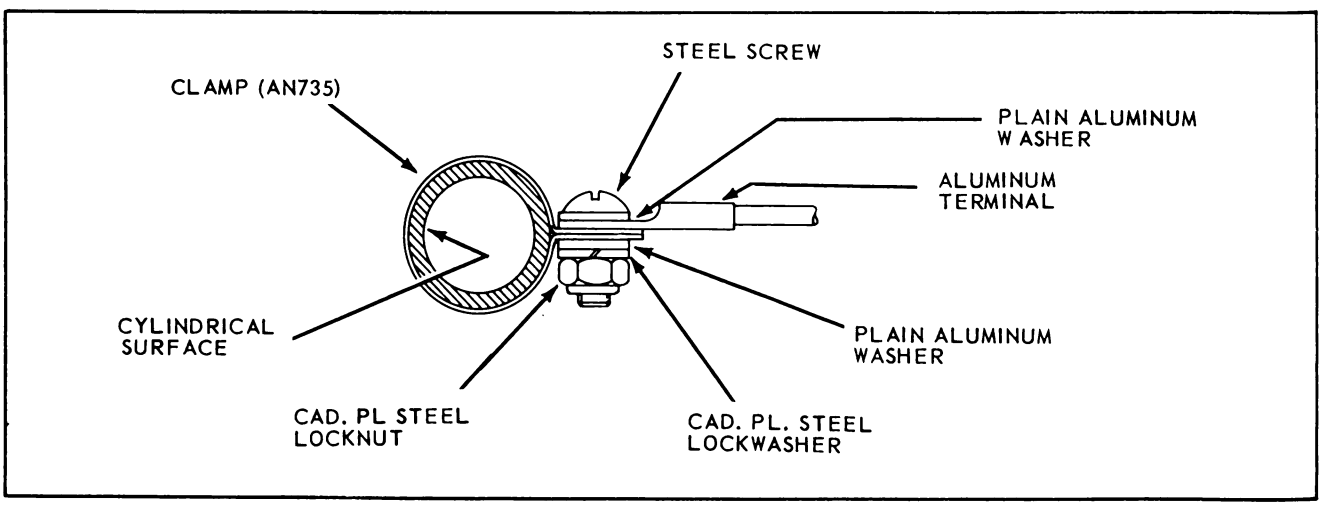


Figure 7–6. Aluminum Jumper Connection to Tubular Structure

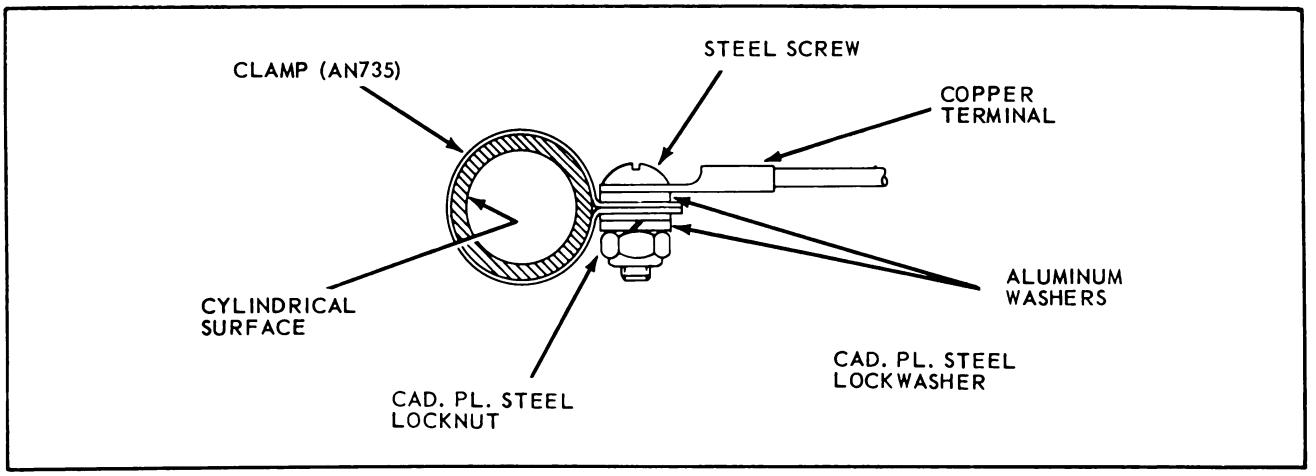


Figure 7–7. Copper Jumper Connection to Tubular Structure

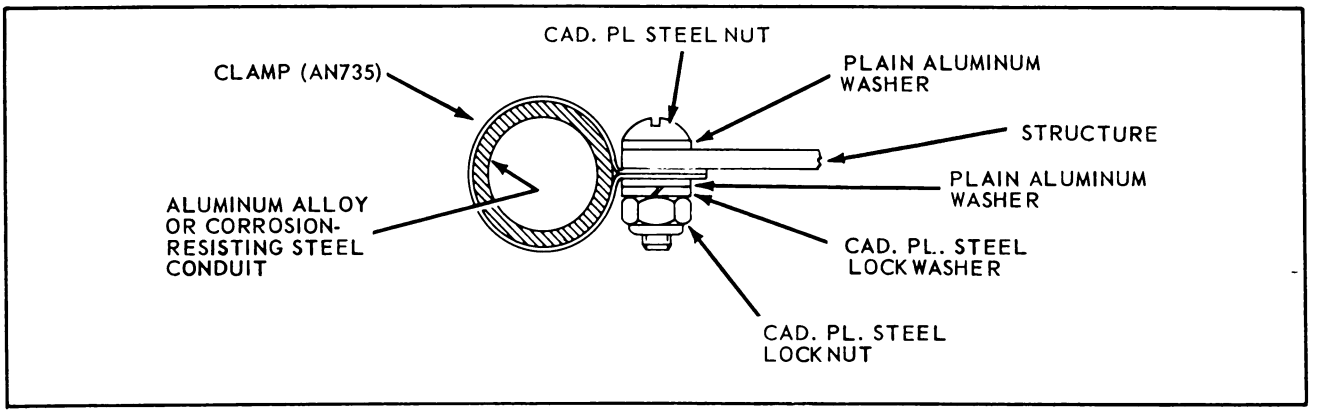


Figure 7–8. Bonding Conduit to Structure

SECTION VIII

BUS BAR PREPARATION

8-1. INTRODUCTION

8-2. GENERAL. Bus bars for an aircraft electrical system must be clean and free from grease, oxide or dirt. Any of these at the electric junction will cause the connections to heat up, and fail. It is also desirable to prevent or minimize oxidation after installation by proper treatment.

8-3. SCOPE. This section describes recommended procedures for cleaning and preparing bus bars prior to installation in aircraft.

8-4. REFERENCE SPECIFICATION.

MIL-W-5088. Wiring, Aircraft, Installation of.

8-5. PREPARATION OF UNPLATED ALUMINUM ALLOY BUS BARS.

8-6. CLEANING. Clean unplated aluminum bus bars thoroughly by immersing in Stoddard's Solvent, or by wiping with a clean soft cloth saturated with the solvent. Wipe dry with a soft, clean cloth.

8-7. After cleaning, treat all electrical contact surfaces as follows:

a. Cover contact surfaces completely with an even coating of petrolatum-zinc dust compound (50% petrolatum, 50% fine zinc dust, by weight.)

b. Scratch brush the coated areas, using a rotary steel wire brush with a pilot as shown in Figure 8-1. Brush through the compound.

c. Remove most of the compound from bus bar by wiping lightly with a soft, clean cloth.

d. Examine bus bar to make sure that there are no steel brush bristles lodged in the aluminum.

e. Apply a thin coating of clean petrolatum-zinc compound to contact surfaces. This compound is the same as that supplied inside MS25021 aluminum terminal lugs.

NOTE

Allow final coat of compound to remain on bus bar when installed. Excess will be squeezed out of connections and removed later.

8-8. PREPARATION OF PLATED ALUMINUM AND COPPER BUS BARS.

8-9. CLEANING. Clean plated aluminum and copper bus bars thoroughly by immersing in Stoddard's Solvent, or by wiping with a clean soft cloth saturated with the solvent. Wipe dry with a clean soft cloth.

8-10. REPAIRING DAMAGED PLATING. Examine contact surfaces of plated aluminum or copper bus bars for damage to plating. Reject damaged aluminum bus bars and return for rework. Repair slight damage to plated copper bus bars by tinning with a soldering iron, or by brush plating. Thoroughly wash and dry brush plated areas.

CAUTION

Do not attempt to repair plating on aluminum bus bars.

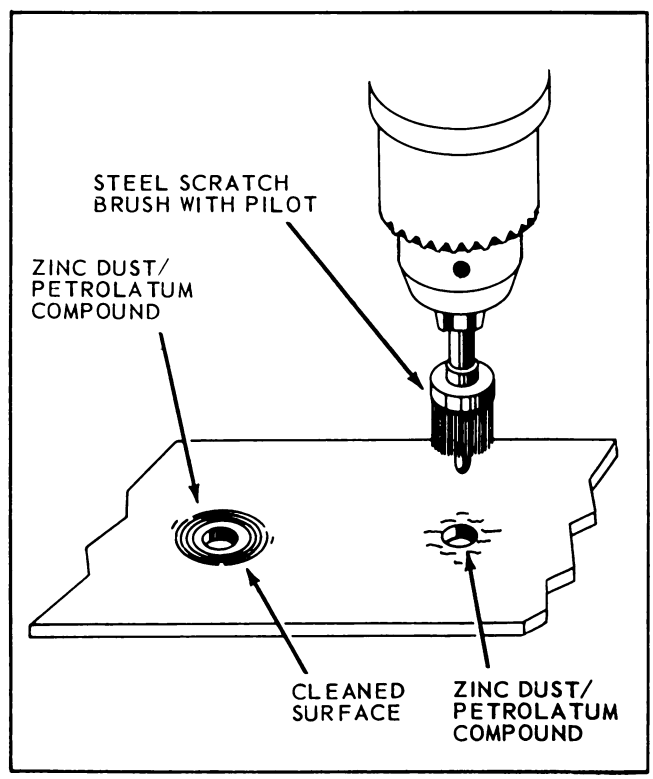


Figure 8-1. Scratch Brushing Unplated Aluminum Alloy Bus Bars

SECTION IX

CONDUIT FABRICATION

9-1. INTRODUCTION.

9-2. PURPOSE. Conduit is used to protect electric wire and cable from abrasion, corrosive fluids, high temperatures, RF interference and damage from cargo handling or activities of aircraft personnel. Conduit is undesirable because of its weight. Therefore conduit is used only in areas where harmful conditions exist, and in as short runs as compatible with its protective function.

9-3. SCOPE. This section outlines recommended procedures for the preparation and fabrication of conduit. For installation of conduit into the aircraft see Section X.

9-4. CONDUIT TYPES. Conduit is available in metallic or non-metallic (plastic) form. Metallic conduit is either rigid or flexible; non-metallic conduit is flexible.

9-5. REFERENCE SPECIFICATIONS AND STANDARD DRAWINGS.

MIL-I-631	Insulation, Electrical, Synthetic-Resin Composition, Non-rigid
JAN-A-669	Anti Seize Compound
MIL-W-5088	Wiring, Aircraft, Installation of
MIL-C-6136	Conduit, Flexible, Shielded, Aluminum Alloy
MIL-I-7444	Insulation Sleeving, Electrical, Flexible
MIL-C-7931	Conduit, Electrical, Flexible, Radio Frequency Shielding
AN3048	Ferrule – Conduit, Flexible, One step Synthetic
AN3050	Ferrule – Conduit, Flexible
AN3051	Ferrule – Conduit, Flexible, One Step
AN3052	Ferrule – Conduit, Flexible, Two Step
AN3053	Ferrule – Rigid Conduit
AN3054	Nut – Conduit Coupling
AN3083	Ferrule – Conduit, Flexible, 2-Step, Synthetic Covered
AND10106	Tubing – Standard Sizes for Aluminum Alloy (52SO Round.)
AND10380	Fitting Installation – Standard AN Conduit
AND10391	Conduit Assembly – Flexible Metallic

9-6. METALLIC CONDUIT.

9-7. GENERAL. Metallic conduit is either rigid or flexible. Rigid metallic conduit is made of aluminum alloy tubing and conforms to the requirements of Standard Drawing AND10106. Aluminum flexible conduit conforms to Specification MIL-C-6136, which covers two types: Type I – Bare Flexible Conduit, and Type II – Rubber covered Flexible Conduit. Brass flexible conduit conforms to Specification MIL-C-7931. Flexible aluminum conduit is used only when it is impracticable to use rigid conduit, such as in areas where the necessary bends are so complex as to interfere with installation, or where there is relative motion between the conduit ends. Flexible brass is used instead of flexible aluminum in areas where it is necessary to minimize RF interference.

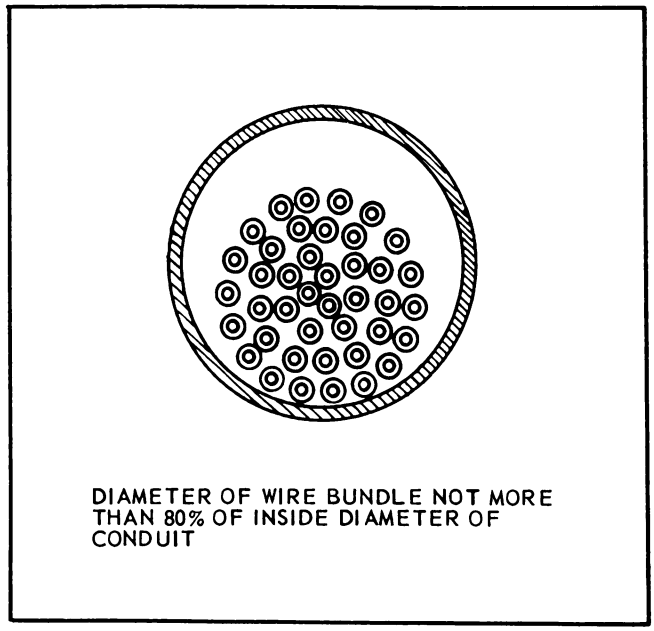


Figure 9–1. Capacity Limits for Conduit

9-8. SELECTION OF CONDUIT SIZE. The protected wire or wire bundle diameter must not be more than 80% of the inside diameter of the conduit.

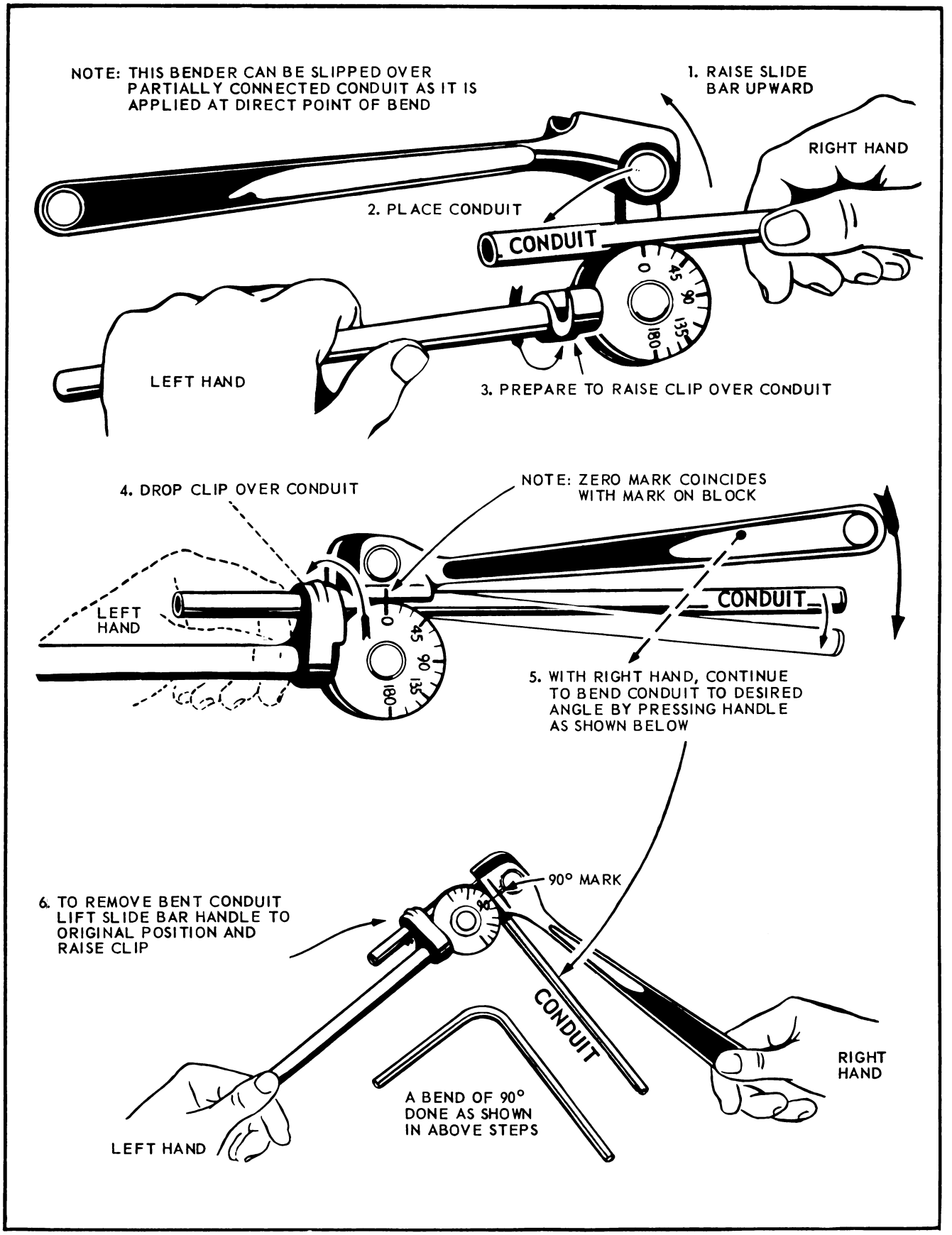


Figure 9–2. Bending Rigid Metallic Conduit

TABLE LXVII

Bend Radii for Rigid Conduit

Nominal Tube OD	*Minimum Bend Radii (Inches)*
1/8	3/8
3/16	7/16
1/4	9/16
3/8	15/16
1/2	1-1/4
5/8	1-1/2
3/4	1-3/4
1	3
1-1/4	3-3/4
1-1/2	5
1-3/4	7
2	8

NOTE

Rigid metallic conduit is supplied in outside diameter sizes. Subtract twice the wall thickness to obtain the inside diameter. Flexible metallic conduit is supplied in inside diameter sizes. No adjustment in diameter is necessary.

9-9. PREPARATION OF RIGID METALLIC CONDUIT. Prepare rigid metallic conduit for fabrication as follows:

Step a. Cut conduit to a length approximately 10% greater than estimated required length using tubing cutter or hack saw.

NOTE

It is not necessary to clean up conduit ends at this point.

Step b. Make required bends in conduit, using a hand tube bender as illustrated in Figure 9-2. Each nominal tube size requires a different bender to get the proper bend radius. See Table LXVII for minimum bend radii allowable for rigid conduit.

CAUTION

When replacing rigid conduit with fittings at both ends make bends as in the original installation. Rigid conduit with fixed end connections must have at least one bend in the run. It cannot be cut or installed accurately enough to avoid mechanical strain on the tubing or fittings. When installing new rigid conduit, avoid a straight path between fixed connections.

Step c. Examine conduit bends for cracks, and for flattening which may reduce the area. When tubing is flattened into an ellipse whose minor diameter is 75% of the nominal tubing diameter, the area is reduced by 10%. If the conduit is flattened more than this, reject it. See Figure 9-3 for examples of good and bad bends.

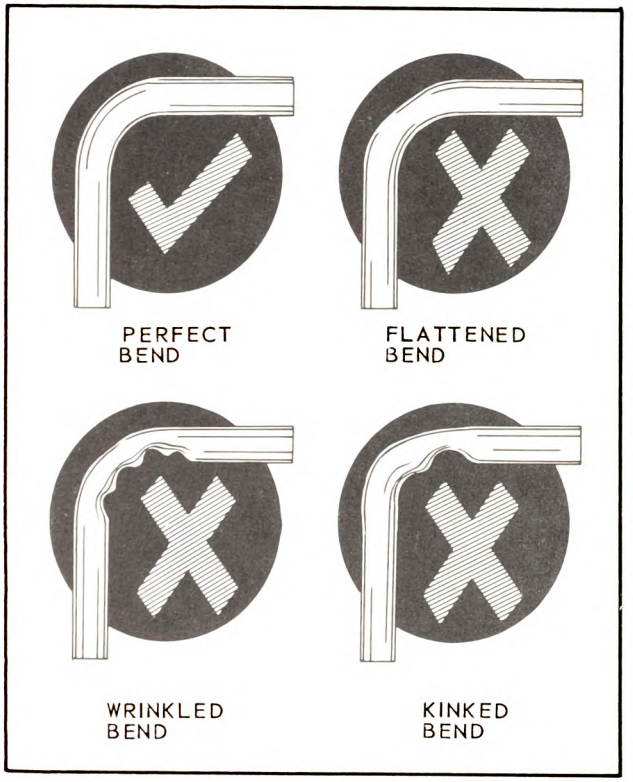


Figure 9–3. Good and Bad Conduit Bends

Step d. Cut conduit to final length with a tubing cutter as shown in Figure 9-4. If a tubing cutter is not available use a hack saw with 32 tooth blade.

Step e. File cut ends of conduit square with a fine toothed flat file. If a hack saw has been used, file the ends of the conduit until all saw marks have been removed.

Step f. Remove burrs from conduit end with a deburring tool. If this is not available, use a file on outside surfaces and a taper reamer on the inside surfaces.

CAUTION

Make sure all sharp edges are removed from conduit ends as they may cut the wire insulation.

9-10. FABRICATION OF RIGID METALLIC CONDUIT. If rigid metallic conduit is to be assembled to a box connector, select a ferrule and nut of the proper size from Table LXVIII. Slide the nut back onto the conduit, and install ferrule on cut end, as shown in Figure 9-5. Connection is tightened when nut is coupled to box connector at assembly. When rigid conduit is not to be attached to a box connector, flare the ends with a spinning tool as shown in Figure 9-6.

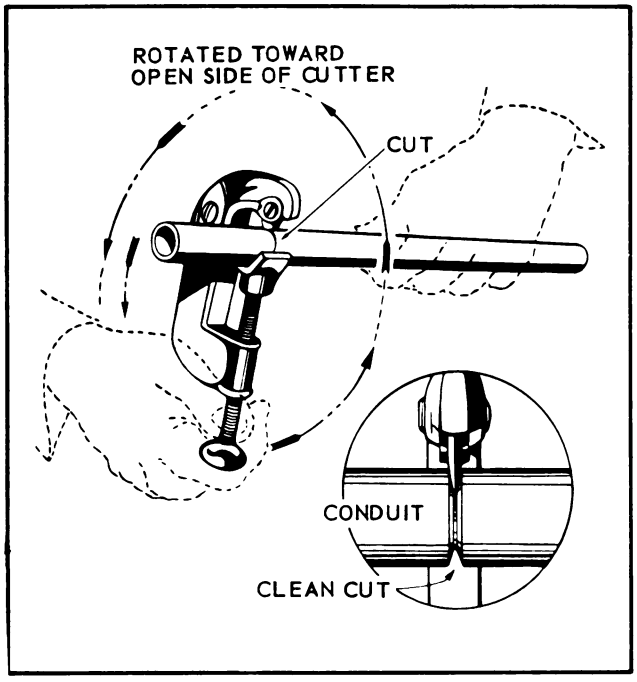


Figure 9–4. Cutting Rigid Metallic Conduit

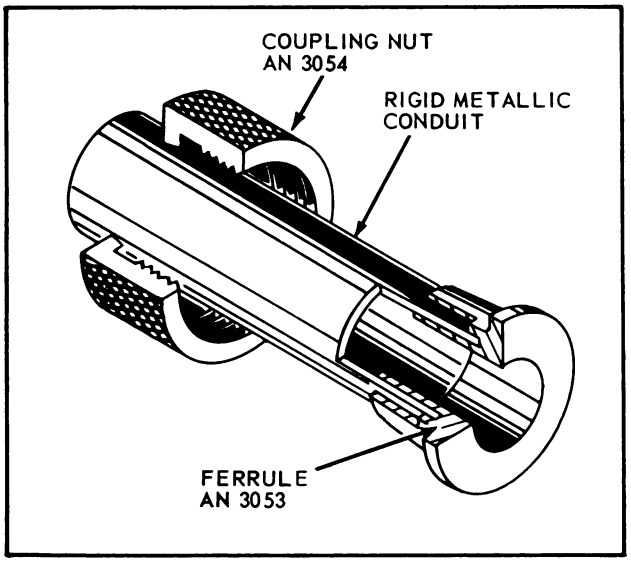


Figure 9–5. Installing Nut & Ferrule on Rigid Metallic Conduit

9-11. PREPARATION OF FLEXIBLE ALUMINUM CONDUIT FOR AMPHENOL FERRULE ASSEMBLY MACHINE. Prepare flexible aluminum conduit prior to fabrication as follows:

Step a. Extend conduit to remove slack and mark length to be cut.

Step b. Place a tight wrap of transparent adhesive tape around *bare* conduit at marked point, so that cut will be made through center of tape. The tape will minimize fraying of the braid during the cutting operation. Do not tape rubber covered conduit.

Step c. Place conduit in appropriate slot of saw vise adapter. The adapter insures that a square cut will be made.

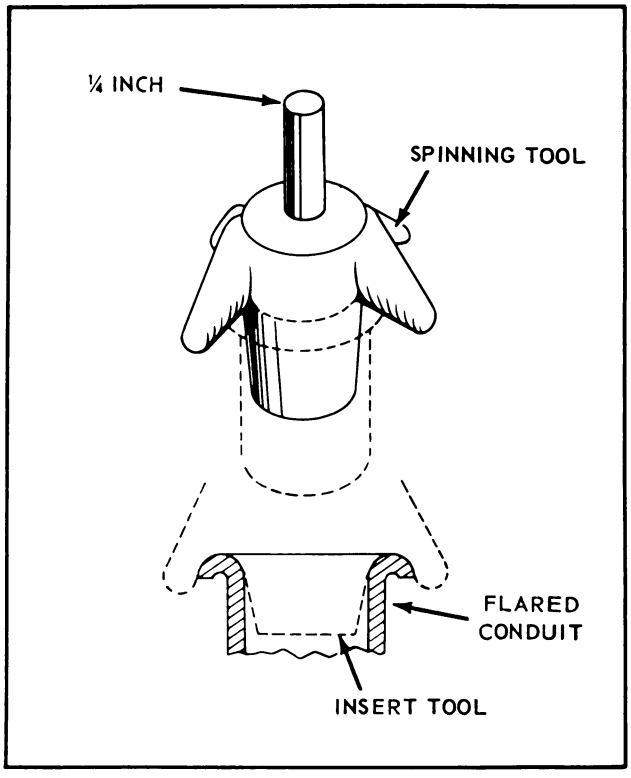


Figure 9–6. Flaring Rigid Metallic Conduit

TABLE LXVIII
"AN" Fittings for Rigid Metallic Conduit

Nominal Conduit Size (O.D.) (inches)	*Ferrule*	*Coupling Nut*
3/16	AN3053-3	AN3054-3
1/4	AN3053-4	AN3054-4
3/8	AN3053-6	AN3054-6
1/2	AN3053-8	AN3054-8
5/8	AN3053-10	AN3054-10
3/4	AN3053-12	AN3054-12
1	AN3053-16	AN3054-16
1-1/4	AN3053-20	AN3054-20
1-1/2	AN3053-24	AN3054-24
1-3/4	AN3053-28	AN3054-28
2	AN3053-32	AN3054-32
2-1/2	AN3053-40	AN3054-40

Step d. Cut through conduit with a hack saw as shown in Figure 9-7.

Step e. Remove tape, if used, from conduit ends.

Step f. Trim frayed ends of braid with end nippers or shears. See Figure 9-8.

Step g. Remove all burrs from inside of conduit at each end with a knife or fine cut round file.

Step h. For rubber covered flexible conduit, strip rubber cover with a knife or stripping fixture as shown in Figure 9-9. See Table LXIX for stripping length.

CAUTION

Do not cut or nick braid.

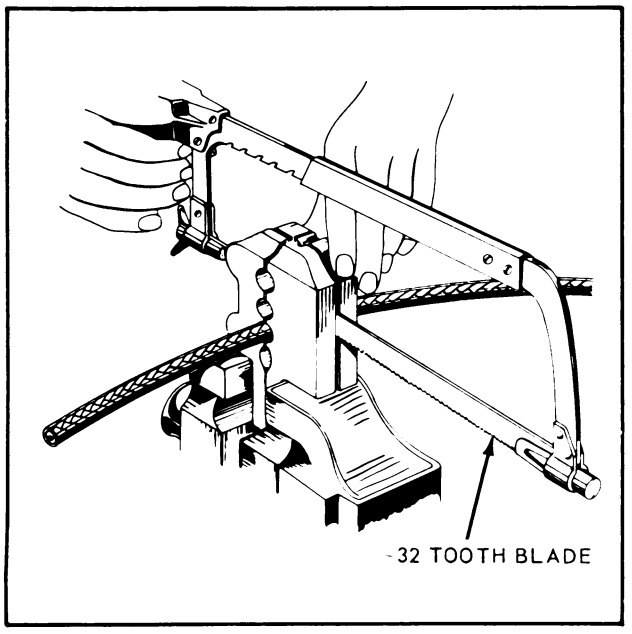


Figure 9-7. Cutting Flexible Conduit

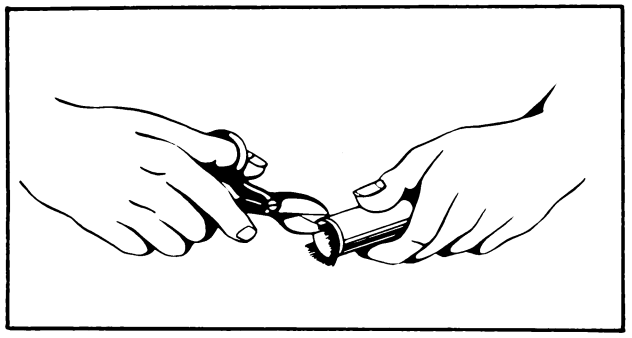


Figure 9-8. Trimming Frayed Ends of Flexible Conduit

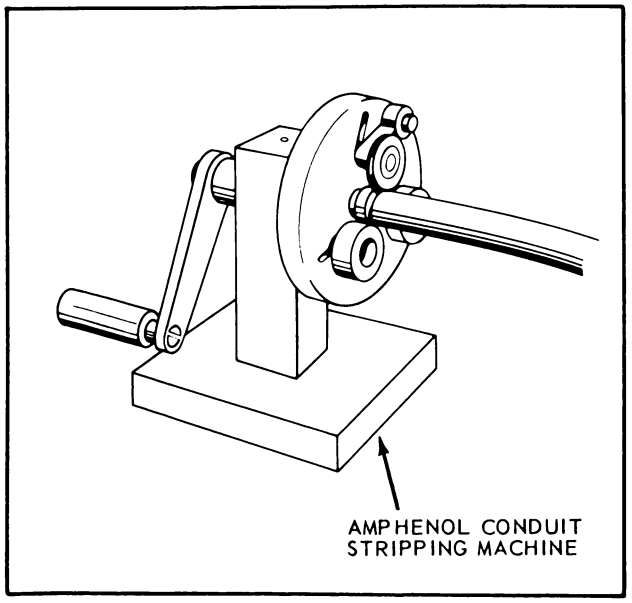


Figure 9-9. Stripping Rubber Cover from Flexible Conduit

TABLE LXIX

Stripping length for Rubber Covered Flexible Conduit

Nominal Conduit Size (Inches)	*Stripping Length* (Inches)
3/16	7/32
1/4	7/32
3/8	7/32
1/2	7/32
5/8	7/32
3/4	1/4
1	5/16
1-1/4	5/16
1-1/2	3/8
1-3/4	7/16
2	1/2
2-1/2	1/2

9-12. PREPARATION OF FLEXIBLE ALUMINUM CONDUIT FOR BREEZE SWAGING MACHINE. Prepare flexible aluminum conduit prior to fabrication, as follows:

Step a. Extend conduit to remove slack, and mark length to be cut.

Step b. Place a tight wrap of transparent adhesive tape around *bare* conduit at marked point, so that cut will be made through center of tape. The tape will minimize fraying of the braid during the cutting operation. Do not tape rubber covered conduit.

Step c. Place conduit in appropriate slot of saw vise adapter. The adapter insures that a square cut will be made.

Step d. Cut through conduit with a hack saw as shown in Figure 9-7.

Step e. Remove tape if used from conduit ends.

Step f. Trim frayed ends of braid with end nippers or shears. See Figure 9-8.

Step g. Remove all burrs from inside of conduit at each end with a knife or fine cut round file.

NOTE

The following steps apply only to rubber covered flexible conduit.

Step h. Trim off rubber cover 1/8 inch with a knife or stripping fixture as shown in Figure 9-9.

CAUTION

Do not nick or cut braid.

Step i. Slide collar selected from Table LXXV on conduit.

Step j. Roll the rubber back on itself so that approximately 1 7/8 inch of braid is exposed.

9-13. PREPARATION OF FLEXIBLE BRASS CONDUIT FOR BREEZE SWAGING MACHINE. Prepare brass conduit prior to fabrication, as follows:

Step a. Extend conduit enough to remove slack, and mark length to be cut, *plus* one inch to allow for fraying of strands during solder dip operation (one half inch will be removed from each end of conduit after solder dip operation.)

Step b. Place conduit in appropriate slot of saw vise adapter. The adapter insures that a square cut will be made.

Step c. Cut through conduit with a hack saw as shown in Figure 9-7.

NOTE

Steps d, e & f, apply only to rubber covered brass flexible conduit.

Step d. Trim off rubber cover 5/8 inch with a knife or trimming fixture as shown in Figure 9-9.

Step e. Slide collar selected from Table LXXV on conduit.

Step f. Roll rubber back on itself so that approximately 3 3/8 inch of braid is exposed.

Step g. Tin ends of conduit in solder pot using rosin-alcohol flux and 50/50 tin-lead solder. Tin approximately one inch at each end.

Step h. Cut approximately one half inch from each end of the conduit, as described in steps b. and c., to required length.

Step i. Trim frayed ends of braid with end nippers or shears as shown in Figure 9-8.

Step j. Remove all burrs from inside of conduit at each end, using a knife or fine cut round file.

9-14. SELECTION OF FITTINGS FOR FLEXIBLE ALUMINUM CONDUIT. Select a ferrule and nut of the required type and size from Table LXX for Bare aluminum (Type I) conduit, or from Table LXXI for rubber covered aluminum (Type II) conduit.

NOTE

Select collar from Table LXXV, in addition to above, for rubber covered conduit if Breeze Swaging machine is used.

9-15. PREPARATION AND USE OF AMPHENOL FERRULE ASSEMBLING MACHINE. Prepare and use ferrule assembling machine, made by Amphenol, as follows:

Step a. Select mandrel with an O.D. that will allow ferrule being used to fit snugly on it, against the mandrel flange. Select a collet which will provide a snug fit on the ferrule lip. See Figure 9-10.

Step b. Rotate mandrel wheel in direction shown by arrow until shaft is fully retracted as in Figure 9-11.

Step c. Rotate adjustment screw in direction shown by arrow until beading rollers are fully retracted.

Step d. Place mandrel in shaft as in Figure 9-12.

Step e. Drop lower half of collet in place.

Step f. Rotate mandrel wheel in direction shown by arrow until mandrel is in light contact with collet.

Step g. Make sure that mandrel is seated in shaft, and tighten set screw with wrench as shown in Figure 9-13.

Step h. Rotate mandrel wheel in opposite direction until mandrel is once again fully retracted.

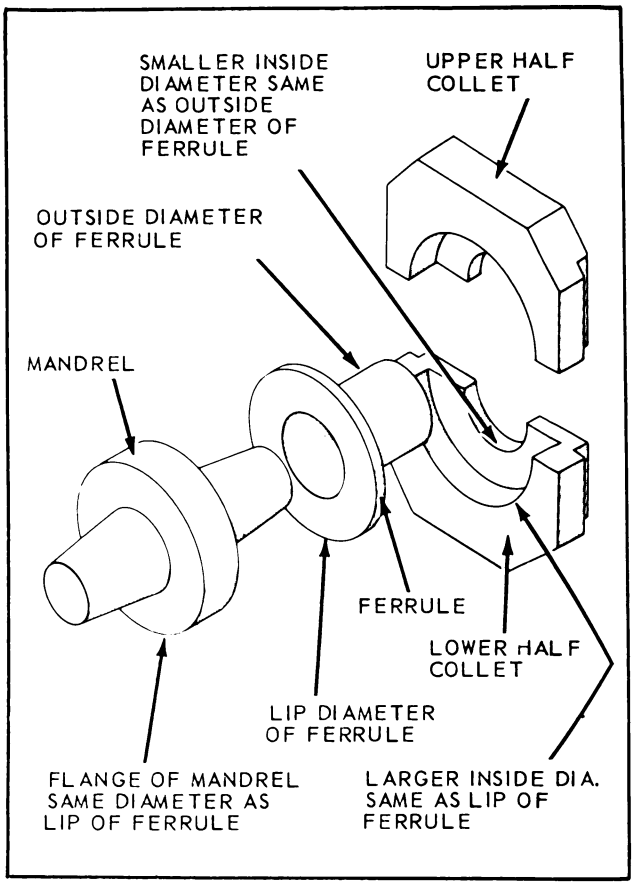


Figure 9–10. Mandrel and Collet for Amphenol Machine

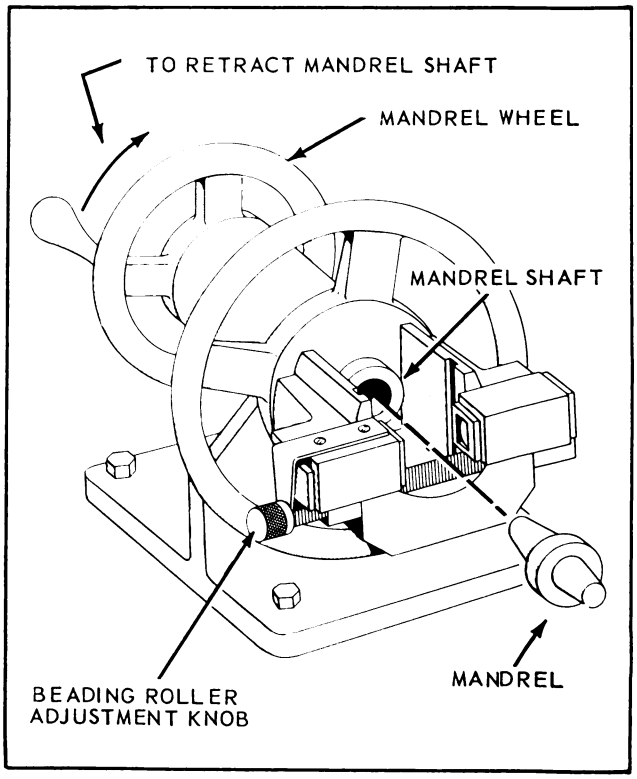


Figure 9–11. Retracting Mandrel Shaft

TABLE LXX

"AN" Fittings for Bare Aluminum (Type I) Flexible Metallic Conduit

Nominal Conduit Size	*Regular Ferrule*	*One-Step Up Ferrule*	*Two-Step Up Ferrule*	*Nut*
3/16	AN3050-3	–	–	AN3054-3
3/16	–	AN3051-3	–	AN3054-4
1/4	AN3050-4	–	–	AN3054-4
1/4	–	AN3051-4	–	AN3054-6
1/4	–	–	AN3052-4	AN3054-8
3/8	AN3050-6	–	–	AN3054-6
3/8	–	AN3051-6	–	AN3054-8
3/8	–	–	AN3052-6	AN3054-10
1/2	AN3050-8	–	–	AN3054-8
1/2	–	AN3051-8	–	AN3054-10
1/2	–	–	AN3052-8	AN3054-12
5/8	AN3050-10	–	–	AN3054-10
5/8	–	AN3051-10	–	AN3054-12
5/8	–	–	AN3052-10	AN3054-16
3/4	AN3050-12	–	–	AN3054-12
3/4	–	AN3051-12	–	AN3054-16
3/4	–	–	AN3052-12	AN3054-20
1	AN3050-16	–	–	AN3054-16
1	–	AN3051-16	–	AN3054-20
1	–	–	AN3052-16	AN3054-24
1-1/4	AN3050-20	–	–	AN3054-20
1-1/4	–	AN3051-20	–	AN3054-24
1-1/4	–	–	AN3052-20	AN3054-28
1-1/2	AN3050-24	–	–	AN3054-24
1-1/2	–	AN3051-24	–	AN3054-28
1-1/2	–	–	AN3052-24	AN3054-32
1-3/4	AN3050-28	–	–	AN3054-28
1-3/4	–	AN3051-28	–	AN3054-32
1-3/4	–	–	AN3052-28	AN3054-40
2	AN3050-32	–	–	AN3054-32
2	–	AN3051-32	–	AN3054-40
2-1/2	AN3050-40	–	–	AN3054-40

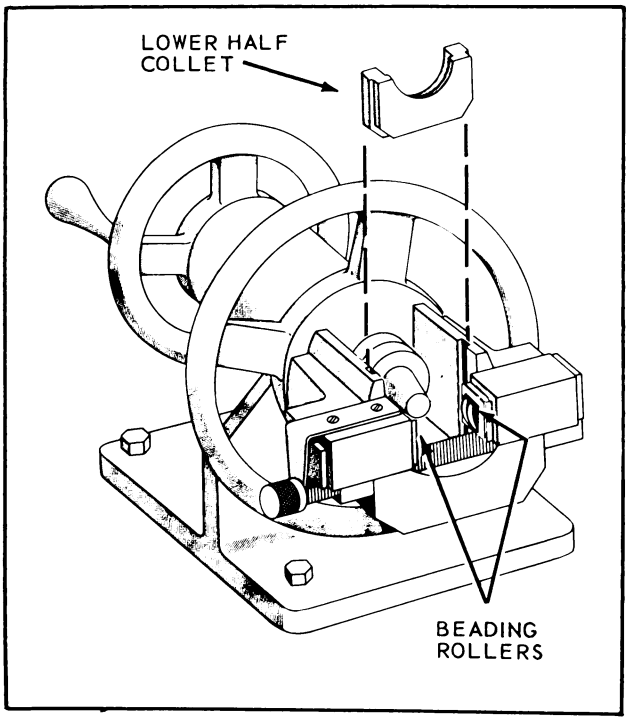


Figure 9–12. Installing Mandrel and Lower Half Collet

Step i. Wash ferrule and nut in Stoddard's solvent to remove petrolatum, and dry thoroughly with air blast. Coat threads of nut with anti-sieze compound (Jan-A-669).

Step j. Slip nut on to conduit, and insert conduit end into ferrule until conduit bottoms, as shown in Figure 9-14.

CAUTION

When fabricating rubber covered (Type II) aluminum conduit, make sure that approximately 1/16" of rubber cover fits inside ferrule as shown in Figure 9-15.

Step k. Rotate mandrel wheel in direction shown by arrow in Figure 9-16a, to move mandrel forward, at the same time slipping conduit and ferrule assembly firmly onto mandrel. Drop upper half of collet into place, and continue rotation of mandrel wheel until ferrule is held firmly between mandrel flange and collet flanges. See Figure 9-16b.

Step l. Turn adjustment screw (Figure 9-17). clockwise until beading rollers exert slight pressure on ferrule.

Step m. Rotate crimping wheel back and forth, at the same time turn adjustment screw clockwise in four steps or until the desired depth of impression is achieved. See Figure 9-18 for illustration of good ferrule crimp.

TABLE LXXI

"AN" Fittings for Rubber Covered Aluminum (Type II) Flexible Metallic Conduit

Nominal Conduit Size	*Regular Ferrule*	*One-Step Up Ferrule*	*Two-Step Up Ferrule*	*Nut*
3/16	AN3050-3	–	–	AN3054-3
3/16	–	AN3051-3	–	AN3054-4
1/4	AN3050-4	–	–	AN3054-4
1/4	–	AN3051-4	–	AN3054-6
1/4	–	–	AN3052-4	AN3054-8
3/8	AN3050-6	–	–	AN3054-6
3/8	–	AN3051-6	–	AN3054-8
3/8	–	–	AN3052-6	AN3054-10
1/2	AN3050-8	–	–	AN3054-8
1/2	–	AN3051-8	–	AN3054-10
1/2	–	–	AN3052-8	AN3054-12
5/8	AN3050-10	–	–	AN3054-10
5/8	–	AN3051-10	–	AN3054-12
5/8	–	–	AN3052-10	AN3054-16
3/4	AN3050-12	–	–	AN3054-12
3/4	–	AN3051-12	–	AN3054-16
3/4	–	–	AN3052-12	AN3054-20
1	AN3050-16	–	–	AN3054-16
1	–	AN3048-16	–	AN3054-20
1	–	–	AN3083-16	AN3054-24
1-1/4	AN3050-20	–	–	AN3054-20
1-1/4	–	AN3048-20	–	AN3054-24
1-1/4	–	–	AN3083-20	AN3054-28
1-1/2	AN3050-24	–	–	AN3054-24
1-1/2	–	AN3048-24	–	AN3054-28
1-1/2	–	–	AN3083-24	AN3054-32
1-3/4	AN3050-28	–	–	AN3054-28
1-3/4	–	AN3048-28	–	AN3054-32
1-3/4	–	–	AN3083-28	AN3054-40
2	AN3050-32	–	–	AN3054-32
2	–	AN3048-32	–	AN3054-40
2-1/2	AN3050-40	–	–	AN3054-40

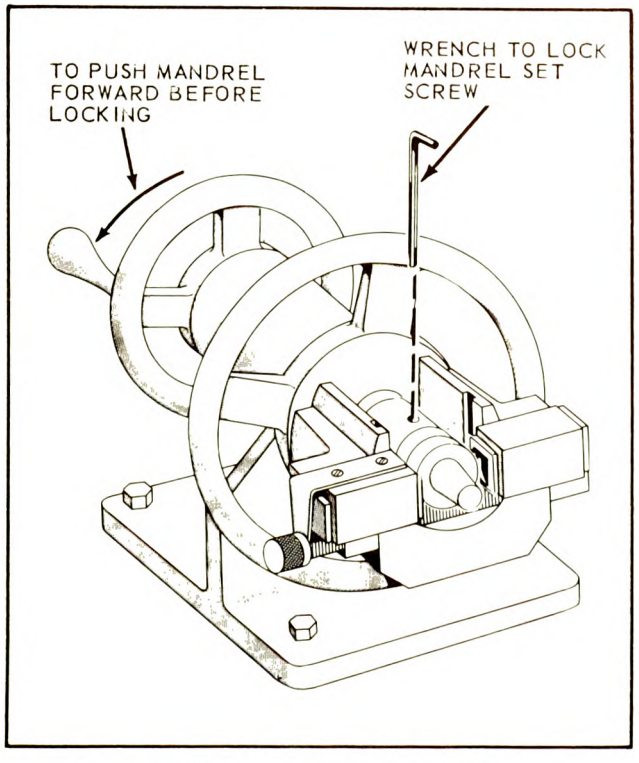


Figure 9–13. Locking Mandrel in Place

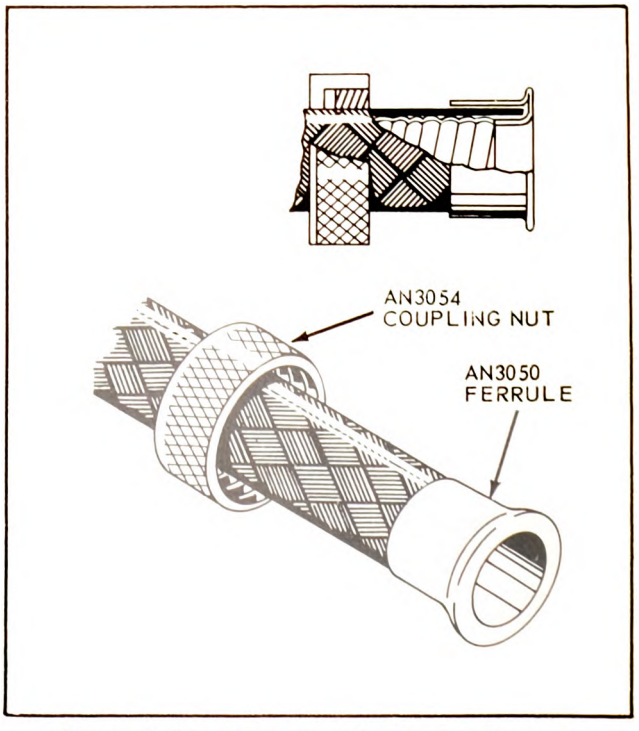


Figure 9–14. Bare Flexible Conduit Ready for Swaging

CAUTION

Do not attempt to get full depth of crimp in one rotation as this will crack the aluminum ferrule. Watch beading closely during the operation, and stop rotation of crimping wheel when sufficient depth is reached.

Step n. Retract beading rollers fully.

Step o. Hold crimped conduit firmly, and retract mandrel fully.

Step p. Remove upper half of collet, and remove crimped conduit.

Step q. Test ferrule crimp by applying 50 pound pull test.

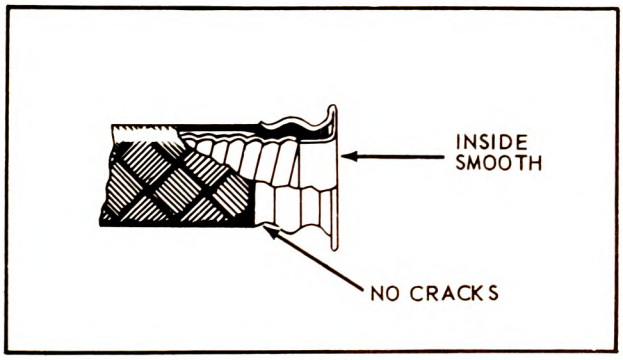


Figure 9–18. Good Crimped Ferrule

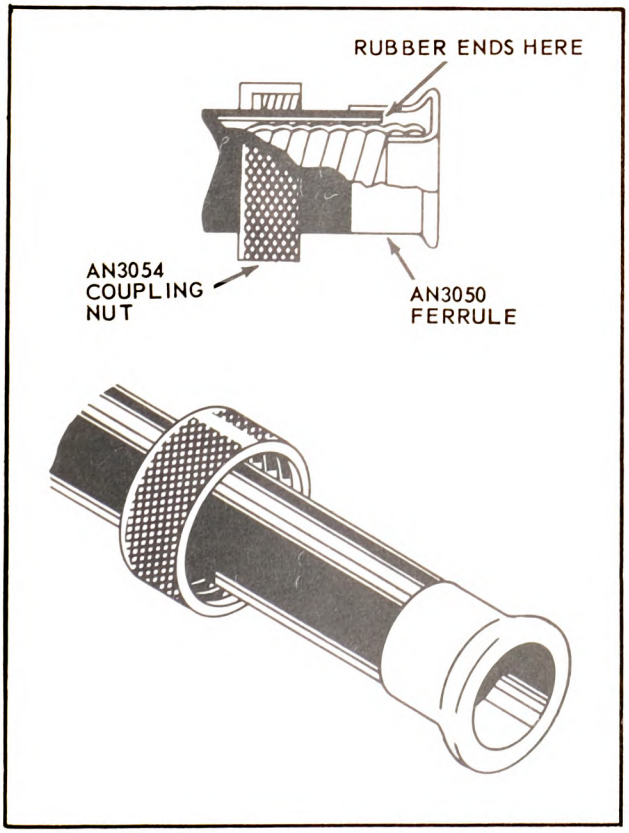


Figure 9–15. Rubber-Covered Flexible Conduit Ready for Swaging

CAUTION

Hold conduit tight and square against ferrule during entire operation.

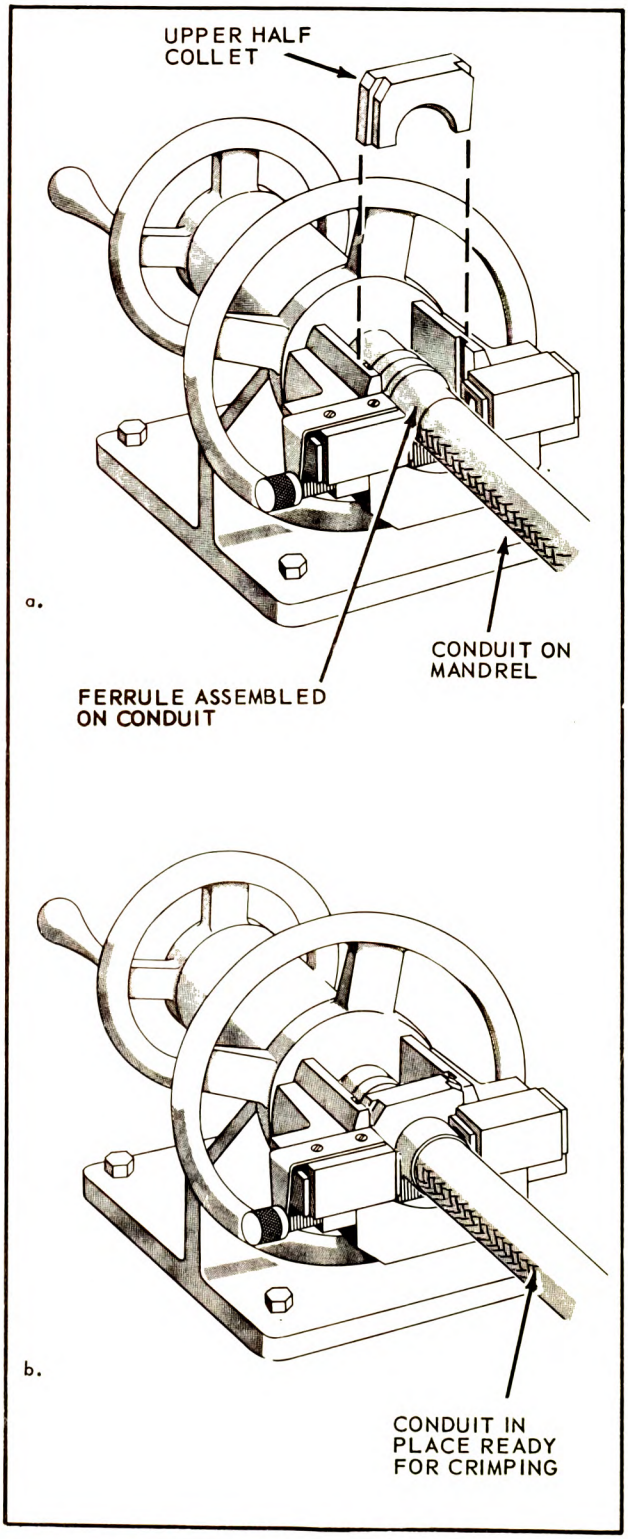


Figure 9–16. Placing Conduit Assembly in Machine

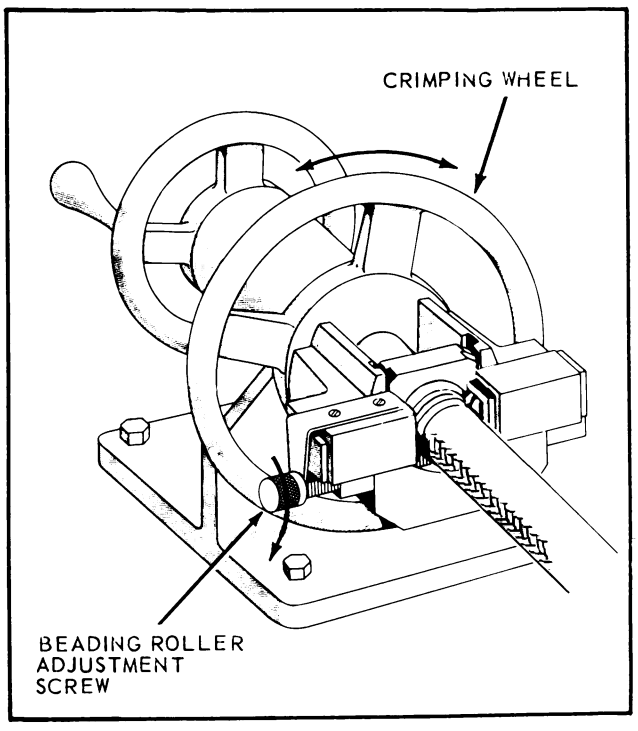


Figure 9–17. Crimping Ferrule

TABLE LXXIII

Ferrule Diameter After Swaging

Conduit Size	*ID of ferrule after swaging*
3/16	.157
1/4	.220
3/8	.345
1/2	.470
5/8	.595
3/4	.720
1	.970
1-1/4	1.225
1-1/2	1.470
1-3/4	1.720
2	1.970
2-1/2	2.470

TABLE LXXIV

Collar Punches and Dies for Breeze Swaging Machine

Nominal Conduit Size	*Collar Punch*	*Collar Die*
3/16	18-3-187	19-8-187
1/4	18-3-250	19-8-250
3/8	18-3-375	19-8-375
1/2	18-3-375	19-8-500
5/8	18-3-625	19-8-625
3/4	18-3-750	19-8-750
1	18-3-1000	19-8-1000
1-1/4	18-3-1250	19-8-1250
1-1/2	18-3-1500	19-8-1500

TABLE LXXII

Accessories for Breeze Swaging Machine

Conduit	*Machine Collar*	*Ferrule Punch*	*Ferrule die*
3/16	–	17-13-0187	19-19-0187
1/4	4257-1-20	15-0250-110	19-19-0250
3/8	4257-1-20	15-0375-110	19-19-0375
1/2	4257-2-20	15-0500-120	19-19-0500
5/8	4257-2-20	15-0625-120	19-19-0625
3/4	4257-2-20	15-0750-120	19-19-0750
1	4257-3-20	15-1000-140	19-1000-40
1-1/4	4257-3-20	15-1250-140	19-1250-40
1-1/2	4257-3-20	15-1500-140	19-1500-40
1-3/4	4257-3-20	15-1750-150	19-1750-40
2	4257-3-20	15-2000-150	19-2000-40
2-1/2	4257-3-20	15-2500-150	19-2500-40

9-16. PREPARATION AND USE OF BREEZE MACHINE FOR FLEXIBLE ALUMINUM CONDUIT.

Prepare and use the Breeze Swaging machine as follows:

a. Place die shoe holder "A" in swaging machine as shown in Figure 9-19. The countersunk portion should face swaging handle "B".

b. Fasten die shoe holder "A" in place by moving plates "C" over edges of die shoe holder. Tighten four screws in plates "C".

c. Select proper punch and die for the ferrule to be swaged from Table VI.

d. Place die "D" in die shoe holder "A" and tighten in place with four screws "E". Oil inside surfaces of die.

e. Place collar "F" over solid end of punch "G" so that collar flange will face swaging handle "B" when installed. Collar "F" has internal spring loaded pins which must enter holes in punch "G".

f. Install punch "G" and collar "F" on plunger "K". Collar flange must face swaging handle "B" end of machine. Use hex wrench through hole in collar to lock punch "G" in place in plunger "K".

Machine is now ready for use. Prepare conduit assembly as follows:

g. Wash ferrule and nut in Stoddard's solvent to remove petrolatum, and dry thoroughly with air blast. Coat threads of nut with anti-seize compound.

h. Slide nut on conduit and insert conduit end into ferrule as far as it will go. See Figure 9-14.

i. Place conduit with ferrule to be swaged in die "D". Pull die handles "H" and "J" down, thus clamping ferrule in position. Only 1/8" of ferrule should be inside die "D".

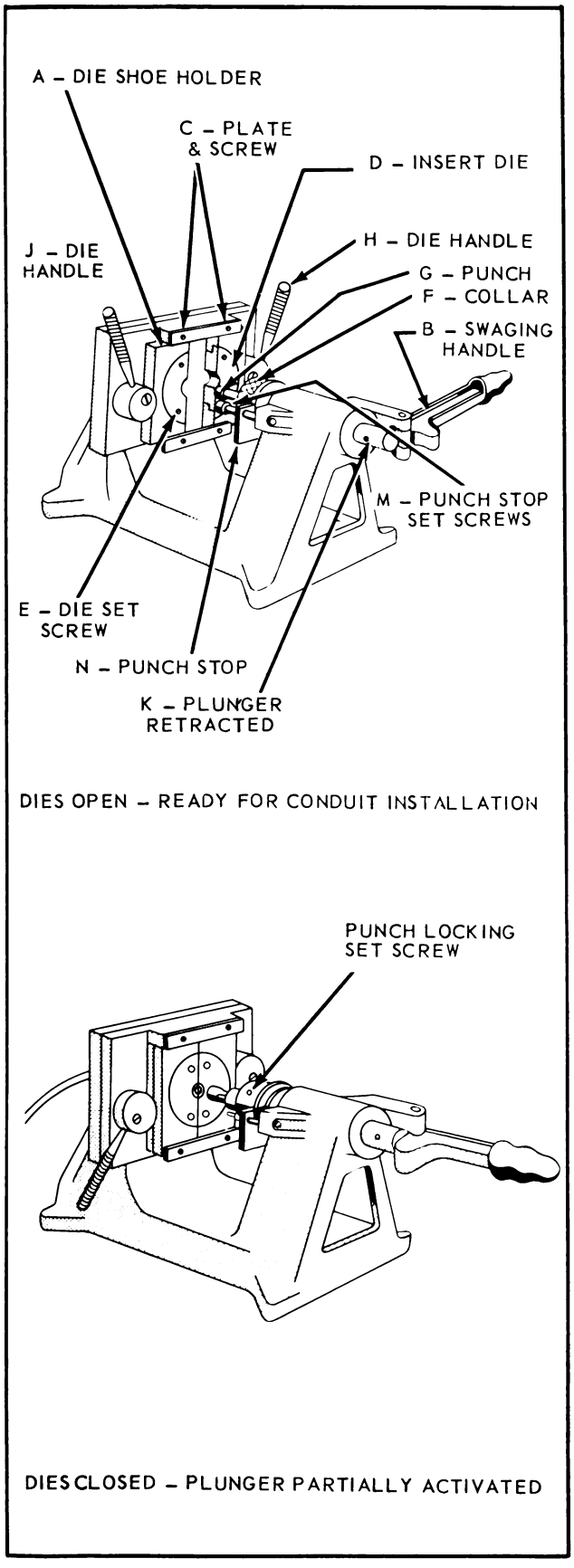


Figure 9–19. Breeze Ferrule Swaging Machine

j. Rotate collar "F" so that internal, spring loaded, pins DO NOT line up with holes in punch. This will prevent the plunger "K" from expanding punch "G" during punch adjustment in next two steps.

k. Loosen punch limit screws "M" and pull gently on swaging handle "B" so that punch forces ferrule into die. Set punch limit screws so that punch "G" does not crush shoulder of ferrule against face of die "D".

l. Flange of collar "F" should now rest against rear (swaging handle end) of punch stop "N", preventing further forward travel of punch.

The machine is now adjusted for repeated swaging operations on similar size ferrules.

m. Rotate collar "F" so that pins LINE UP with holes in punch. This cannot be seen but can be felt.

n. Pull handle "B" forward, expanding punch "G" inside of ferrule. This is the swaging operation. Repeat several times to obtain smooth surface inside ferrule.

o. Release swaging handle "B" and die handles "H" and "J" to remove conduit from machine.

p. Check inside diameter of ferrule to dimensions in Table LXXIII. If inside diameter is too small, repeat steps i and n. If inside diameter is too large, reject the assembly.

q. Test ferrule crimp by applying 50 pound pull test.

NOTE

The following steps (r through w) apply only when rubber covered conduit is being fabricated.

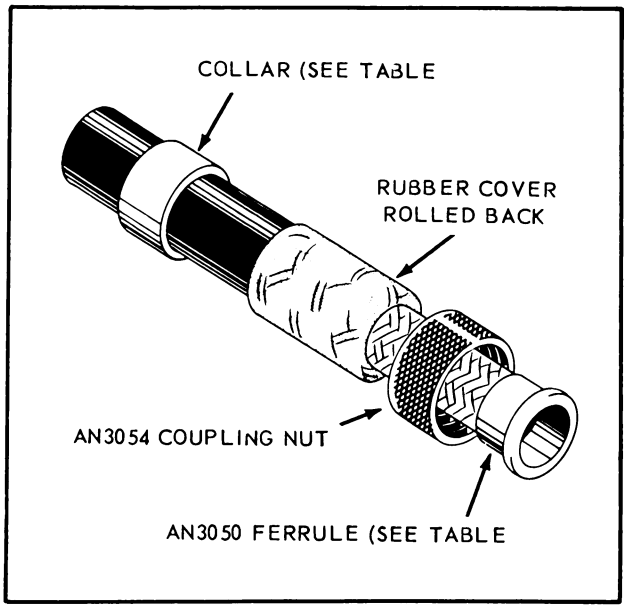


Figure 9–20. Rubber-Covered Conduit Prepared for Breeze Machine

r. Remove dies "D", collar "F" and punch "G" from machine. Select new dies and punch to match conduit diameter from Table LXXIV. Install these parts in same manner as previous installations of dies and punch.

NOTE

The collar "F" is omitted from machine for the following operation.

s. Roll rubber cover of conduit back in place, and slide conduit collar into position as shown in Figure 9-21. Temporarily insert 1/32 inch spacer between conduit collar and back of nut.

t. Fit conduit into machine so that conduit collar fits into cutout in dies "D".

u. Close die handles "H" and "J".

v. Pull swaging handle "B" to swage conduit collar onto conduit.

w. Remove temporary spacer and examine clearance between nut and collar. Use a knife to remove any rubber extruded from under collar.

9-17. SELECTION OF FITTINGS FOR FLEXIBLE BRASS CONDUIT. Select ferrule and nut for *bare* flexible brass conduit from Table LXXV. Use the same ferrule and nut from Table LXXV, for *rubber covered* brass conduit, and add conduit collar of appropriate size.

9-18. FABRICATION OF FLEXIBLE BRASS CONDUIT. Refer to Figures 9-19 through 9-21. Fabricate flexible brass conduit, using Breeze swaging machine, as follows:

a. Dip ferrule and nut, (and collar, when rubber covered brass conduit is being used), in Stoddard's solvent to remove petrolatum. Dry thoroughly with air blast.

b. Tin rear half of ferrule, using rosin-alcohol flux and 50/50 tin-lead solder. Use solder pot for this operation.

c. Slip nut onto conduit and insert pre-tinned conduit end into ferrule until conduit bottoms.

d. Swage ferrule to conduit following instructions listed in paragraph 9-16, steps a through q.

e. Solder ferrule to conduit with electrical resistance unit as shown in Figure 9-22, using rosin core 60/40 tin-lead solder. Fill with solder until there are no blow holes between ferrule and conduit, and the exterior is smooth.

f. Lubricate threads of nut with JAN-A-669, anti-seize compound. When rubber-covered brass conduit is being fabricated, swage collar to conduit as instructed in paragraph 9-16, steps r through w.

9-19. NON-METALLIC CONDUIT.

9-20. GENERAL. Non-Metallic conduit is made of flexible plastic tubing, conforming to Spec. MIL-I-631 or MIL-I-7444.

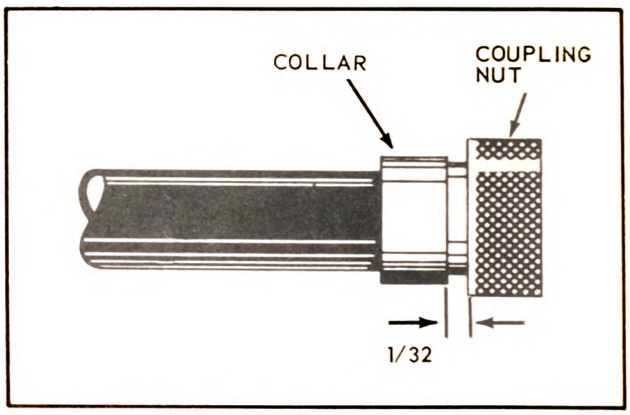


Figure 9–21. Final Position of Collar on Rubber-Covered Conduit

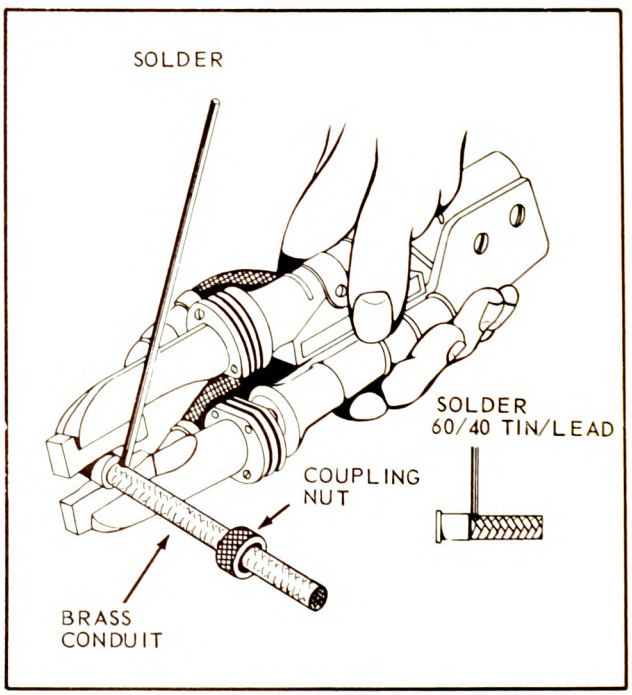


Figure 9–22. Soldering Ferrule to Brass Conduit

CAUTION

Use non-metallic conduit ONLY in areas where the ambient temperature is less than 200°F.

9-21. FABRICATION OF NON-METALLIC CONDUIT USING TWO-PIECE FERRULES. Fabricate non-metallic conduit with two-piece ferrules, as follows:

a. Cut plastic tubing to required length.

b. Slip an AN 3054 Nut and the female ferrule over conduit.

c. Insert male ferrule into conduit end.

d. Move female ferrule toward end of conduit over male ferrule, until the ferrule flanges are a maximum of 1/32 inches apart as shown in Figure 9-23.

TABLE LXXV

Breeze fitting for Flexible Brass Conduit

Nominal Conduit Size	*Regular Ferrule*	*One Step Ferrule*	*Two Step Ferrule*	*Nut*	* *Brass or Aluminum collar, for covered conduit*
3/16	11-1-B3			118-22-B3	117-3-B0187
		11-1-B3		118-22-B4	
			11-3-B3	118-22-B6	
1/4	11-1-B4			118-22-B4	117-3-B0250
		11-2-B4		118-22-B6	
			11-3-B4	118-22-B8	
3/8	11-1-B6			118-22-B6	117-3-B0375
		11-2-B6		118-22-B8	
			11-3-B6	118-22-B10	
1/2	11-1-B8			118-22-B8	117-3-B0500
		11-2-B8		118-22-B10	
			11-3-B8	118-22-B12	
5/8	11-1-B10			118-22-B10	117-3-B0625
		11-2-B10		118-22-B12	
			11-3-B10	118-22-B16	
3/4	11-1-B12			118-22-B12	117-3-B0750
		11-2-B12		118-22-B16	
			11-3-B12	118-22-B20	
1	11-1-B16			118-22-B16	117-3-B1000
		11-2-B16		118-22-B20	
			11-3-B16	118-22-B24	
1-1/4	11-1-B20			118-22-B20	117-3-B1250
		11-2-B20		118-22-B24	
			11-3-B20	118-22-B28	
1-1/2	11-1-B24			118-22-B24	117-3-B1500
		11-2-B24		118-22-B28	
			11-3-B24	118-22-B32	
1-3/4	11-1-B28			118-22-B28	–
		11-2-B28		118-22-B32	
			11-3-B28	118-22-B40	
2	11-1-B32			118-22-B32	117-3-B2000
		11-2-B32		118-22-B40	
2-1/2	11-1-B40			118-22-B40	117-3-B2500

*Substitute 'A' for Aluminum in place of 'B' for brass.

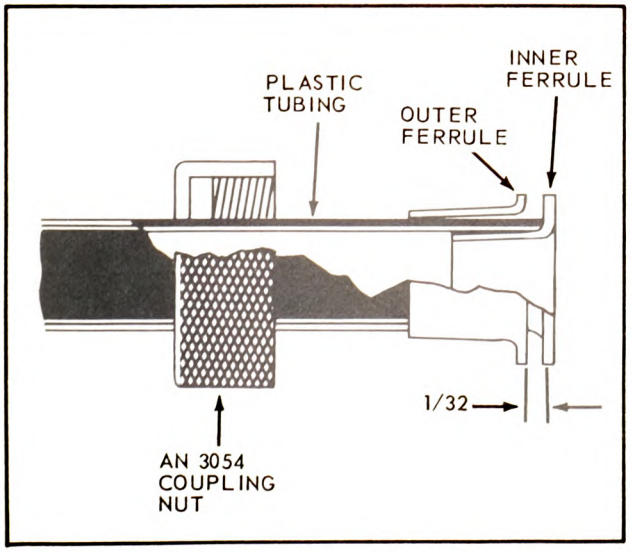


Figure 9–23. Installing Two-Piece Ferrules on

e. Lubricate threads of nut with JAN-A-669, anti-seize compound.

This completes the fabrication prior to assembly to mating equipment.

NOTE

During assembly to mating equipment, the tightening of the nut to the equipment will lock the ferrule onto the flexible conduit.

SECTION X
INSTALLATION OF BUSBARS, CONDUIT, JUNCTION BOXES, PROTECTIVE DEVICES, AND TERMINAL STRIPS.

10-1. INTRODUCTION.

10-2. PURPOSE. Procedures for installing equipment in aircraft are recommended in order to make installation easier, to standardize the methods used, and to provide the best possible protection for personnel and equipment.

10-3. SCOPE. This section describes the recommended procedures for installing busbars, conduit, junction boxes, protective devices and terminal strips in aircraft. It also describes methods of identification and protection and the proper usage of hardware.

10-4. REFERENCE SPECIFICATIONS AND DRAWINGS.

MIL-I-631	Insulation, Electrical, Synthetic-resin
MIL-W-5088	Wiring, Aircraft, Installation of
MIL-C-6136	Conduit, Flexible, Shielded Aluminum alloy
MIL-E-7080	Electrical Equipment; Installation of Aircraft, General Specification
MIL-I-7444	Insulation Sleeving, Electrical, Flexible
AN 3436 (Dwg)	Terminal Block Assembly, Electrical
AND 10106 (Dwg)	Tubing, Aluminum Alloy, Round (52 SO) Std. Sizes
AND 10391	Conduit Assembly, Flexible Metallic
AND 10380 (Dwg)	Fitting Installations, Std. AN Conduit
AND 10449 (Dwg)	Circuit Breaker Installation

10-5. INSTALLATION OF BUSBARS.

10-6. GENERAL. Busbars are installed in aircraft as means of power distribution. Busbar materials most commonly used are plated aluminum, bare aluminum or plated copper. The aluminum used is E C (Electrical) grade.

10-7. MOUNTING HARDWARE. See Figure 10-1. When installing a copper busbar, always place a cadmium plated steel plain washer between the busbar and the lockwasher or self-locking nut. When installing an aluminum alloy busbar, place an aluminum alloy plain washer between the busbar and the lockwasher or self locking nut.

10-8. INSULATION. Insulate the busbar from structure, junction box, or support with a fiber-glass, phenolic or other rigid insulating stand-off, as shown in Figure 10-1. Do not use any moisture-absorbing material.

10-9. PROTECTION. Install busbars inside panels, junction boxes or in protected areas when possible. If this cannot be done, protect the busbar with a vinyl tube tied in place after connections have been made. See Section XI for details.

10-10. INSTALLATION OF CONDUIT.

10-11. GENERAL. Metallic conduit, both rigid and flexible, used in aircraft to protect electrical wires and cables, is installed before the wiring is routed through it. Non-metallic conduit is installed at the same time the wiring is routed, and the procedure is described in Section XI. For the preparation of conduit prior to installation see Section IX.

10-12. SUPPORTING HARDWARE. Attach conduit to aircraft structure with clamps. For rigid or bare flexible metallic conduit, select a plain aluminum clamp (AN742) of the proper size from Table LXXVI. For rubber covered flexible metallic conduit, select a cushioned clamp (MS 21919) of the proper size from Table LXXVII. Measure the O.D. of conduit to determine size for use in Table LXXVII.

10-13. INSTALLATION OF SUPPORTING HARDWARE. Attach clamps to a rigid surface of structure, so that there will be no relative motion between conduit and aircraft structure. Install clamps so that the mounting screw is above the conduit as shown in Figure 10-2. Install clamps so that conduit slants downward toward one end, when the aircraft is on the

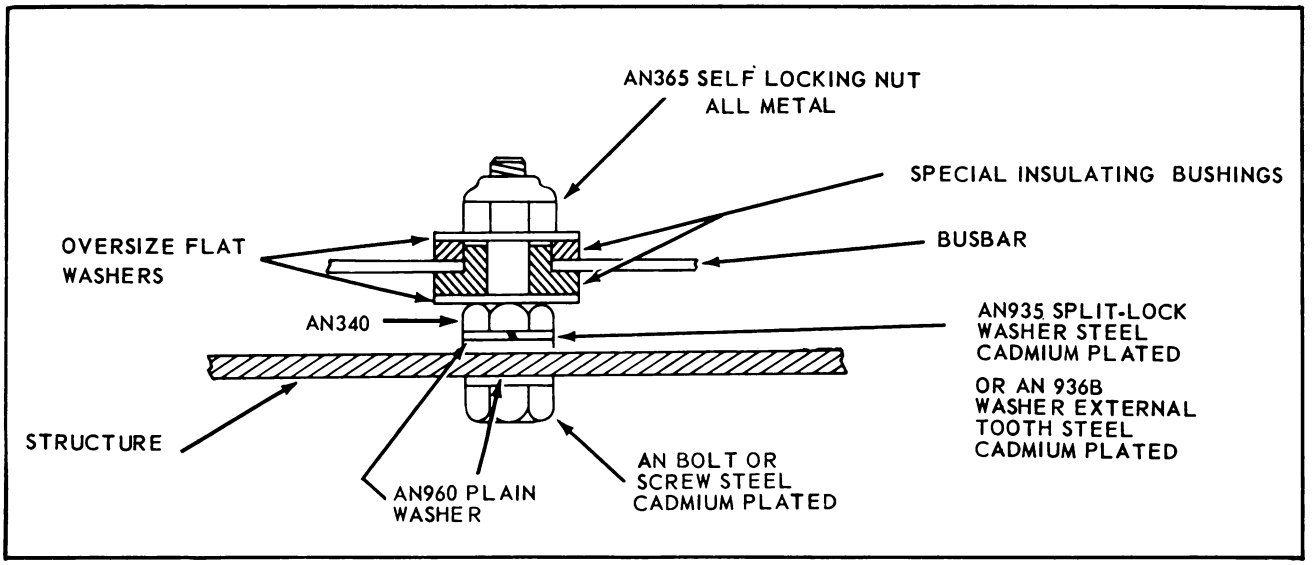


Figure 10–1. Mounting Busbars to Structure

TABLE LXXVI

Support Clamps for Rigid or Flexible Bare Aluminum Conduit

Nominal O.D. of Conduit	*AN Clamp*
3/16	AN 742D3
1/4	AN 742D4
3/8	AN 742D6
1/2	AN 742D8
5/8	AN 742D10
3/4	AN 742D12
1	AN 742D16
1-1/4	AN 742D20
1-1/2	AN 742D24
1-3/4	AN 742D28
2	AN 742D32
2-1/2	AN 742D40

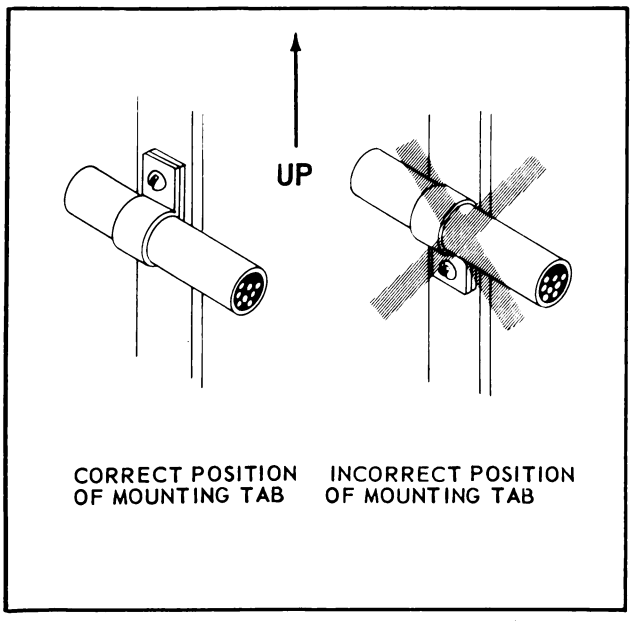


Figure 10–2. Installation of Supporting Clamps for Conduit

TABLE LXXVII

Support Clamps for Rubber Covered Flexible Aluminum or Brass Conduit

MS Clamp Number	*Nominal ID of clamp (inches)*
MS 21919D5	.313
MS 21919D6	.375
MS 21919D7	.438
MS 21919D8	.500
MS 21919D9	.563
MS 21919D10	.625
MS 21919D11	.688
MS 21919D12	.750
MS 21919D13	.873
MS 21919D14	.875
MS 21919D15	.938
MS 21919D16	1.000
MS 21919D19	1.188
MS 21919D21	1.313
MS 21919D23	1.438
MS 21919D25	1.563
MS 21919D27	1.688
MS 21919D29	1.812
MS 21919D31	1.938
MS 21919D33	2.062
MS 21919D35	2.188
MS 21919D37	2.312
MS 21919D43	2.688
MS 21919D45	2.812

ground. If one end is attached to equipment, slant conduit toward the open end away from the equipment.

CAUTION

Do not tighten clamps on conduit so that they damage or collapse the conduit. Reject and replace conduit that has been collapsed.

10-14. SPACING OF SUPPORTS. See Figure 10-3. Support rigid metallic conduit with a clamp close to each end, and at maximum spacing of 3 feet along entire conduit run. Support flexible metallic conduit with clamps close to each end, and spaced 6" minimum to 24" maximum apart. Spacing of support clamps within the limits given is determined by conditions of structure.

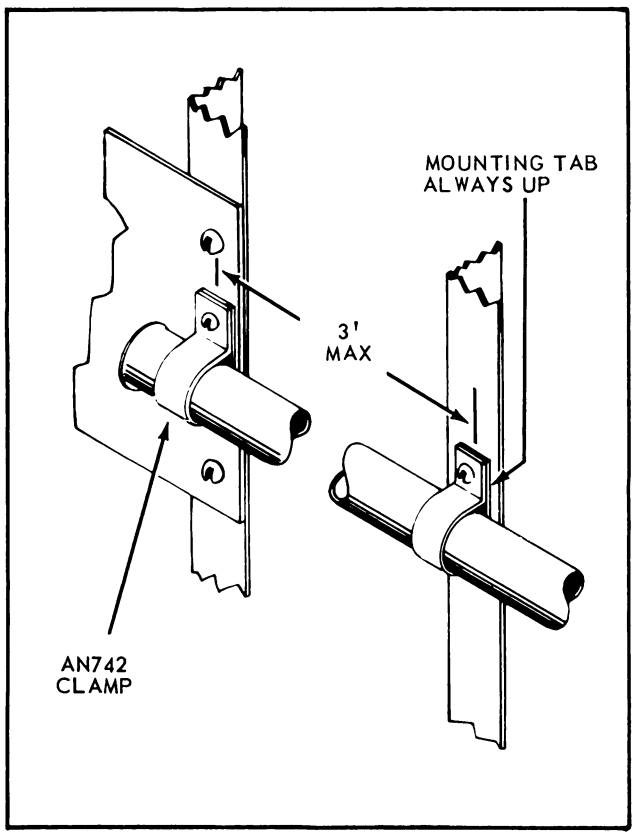


Figure 10–3. Spacing Clamps for Rigid Metallic Conduit

10-15. BENDING LIMITATIONS. Rigid metallic conduit is bent as required before installation. See Section IX, paragraph 9-9, step b. for procedure. Form bends in flexible metallic conduit to radii given in Table LXXVIII. Where non-military Specification conduit has been used in the aircraft, replace with conduit of the same type, and bend as in the original installation.

CAUTION

Make sure that conduit is not overstressed on installation; that is there should be no strain on ferrules. Install conduit so that there will be no vibration flexing of the conduit at ferrules.

TABLE LXXVIII

Minimum Bending Radii for Flexible Aluminum or Brass Conduit

Nominal I.D. of Conduit (inches)	*Minimum Bending Radius inside (inches)*
3/16	2-1/4
1/4	2-3/4
3/8	3-3/4
1/2	3-3/4
5/8	3-3/4
3/4	4-1/4
1	5-3/4
1-1/4	8
1-1/2	8-1/4
1-3/4	9
2	9-3/4
2-1/2	10

10-16. DRAINAGE. Do not drill drainage holes in metallic conduit. Drainage is provided for as described in paragraph 10-13. Procedure for making drainage holes in non-metallic conduit is described in Section XI, paragraph 11-23.

10-17. INSTALLATION OF JUNCTION BOXES.

10-18. GENERAL. Junction boxes are containers, with hinged or removeable covers, used in aircraft to provide a protected area for electrical power distribution equipment such as busbars and terminal strips. The material of Junction Boxes is either metal or hard fiber-glass.

10-19. MOUNTING HARDWARE. See Figure 10-4. Use standard AN bolts or screws of the appropriate size to attach Junction Boxes to aircraft structure. Insert screws of bolts so that the head of the screw or bolt is inside the Junction Box.

CAUTION

Do not install attaching hardware so that threaded part of the screw or bolt protrudes inside the junction box, as the sharp thread edges will damage wire insulation.

10-20. INSULATION. The inside of metallic junction boxes is coated with white glyptal or similar material to insulate wiring from the metal, to improve visibility and to make inspection easier. Non-metallic junction boxes need not be so insulated. If this coating is damaged during the installation procedure, repair the damaged parts with the same material as used in the original installation. When a new metallic box is installed, make sure the insulating compound is present and undamaged.

10-21. JUNCTION BOX COVERS. Junction Box covers may be hinged, or attached by means of screws. Screw threads must not extend into the box. The sharp threads may cut wire insulation. If covers are not

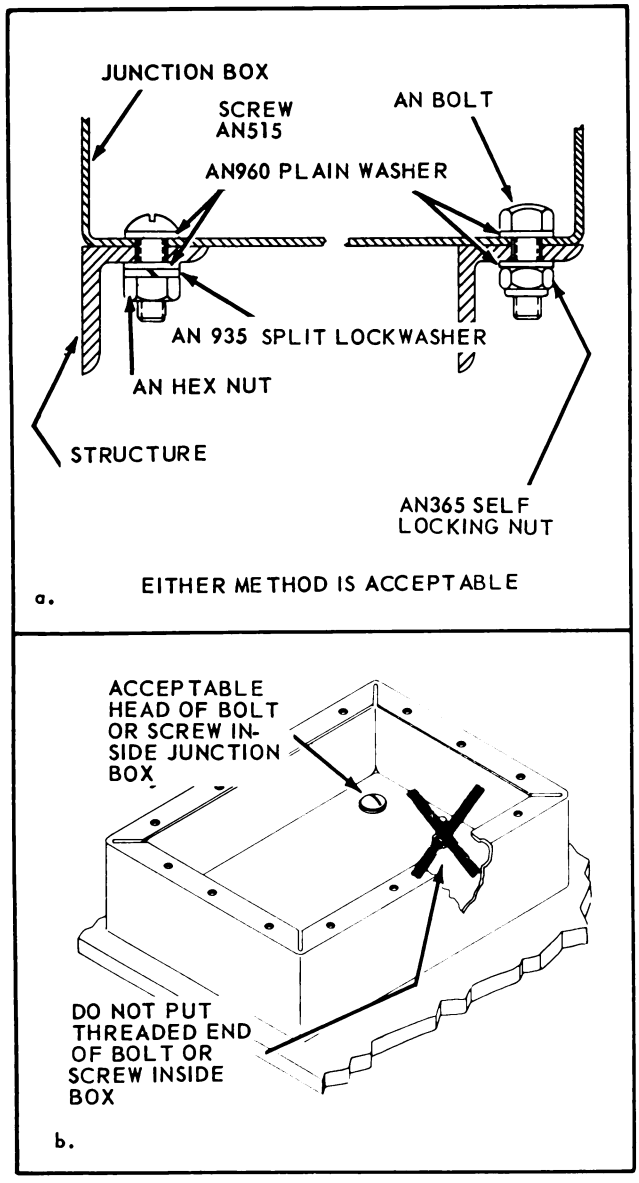


Figure 10–4. Attaching Junction Box to Structure

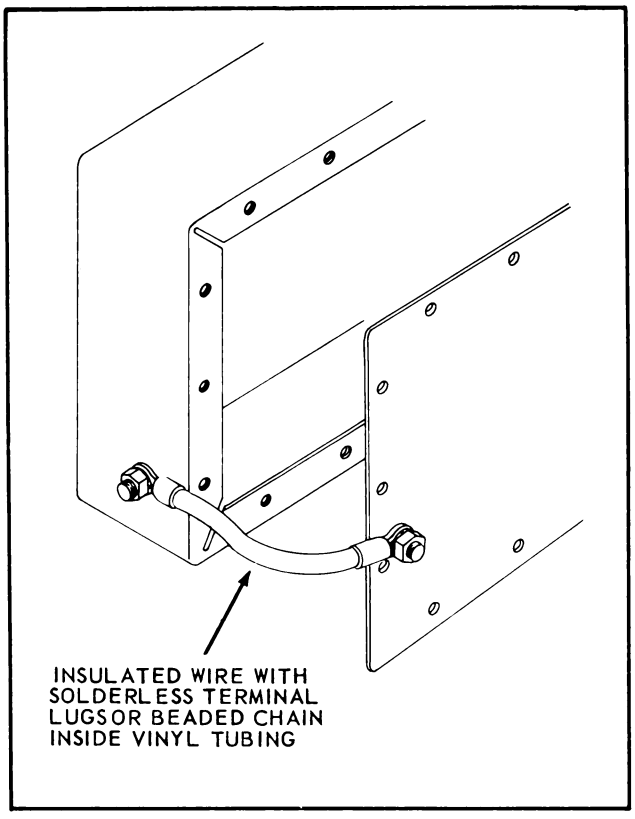


Figure 10–5. Attaching Cover to Junction Box

hinged, secure the cover to the box with an insulated bead chain, or #14 wire, as shown in Figure 10-5. Make this attachment outside the box so that when the the box is closed the chain or wire will not interfere with the wiring.

NOTE

If covers are bent during installation or repair, straighten them before final attachment.

10-22. PREPARATION OF WIRE ENTRY HOLES. Determine the outside diameter of the wire, or wire bundle, and make sure that the opening is at least 1/8 inch larger in diameter to permit later enlargement of the bundle. Use a box connector and cable clamp to protect wiring if this is indicated on the engineering drawing. When a box connector is not used, protect the edges of the entry hole with plastic or fibre grommets. See Figure 10-6.

10-23. DRAINAGE OF JUNCTION BOXES. Provide one or more drainage holes 3/16" diameter minimum, at the lowest point of the Junction Box when the aircraft is on the ground. When drilling drainage holes in metal junction boxes, deburr the edges of the hole with a deburring tool or a file.

CAUTION

Do not drill holes in vapor-tight junction boxes.

10-24. VAPOR TIGHT BOXES. Vapor-tight junction boxes in aircraft are identified as such on the covers. When doing work of any kind on vapor-tight boxes carefully follow the instructions given in the aircraft manufacturers Handbook of Maintenance Instructions for the specific airplane model.

10-25. IDENTIFICATION. If Junction Boxes as originally installed are not identified, it is not necessary to do so. If the Junction box does have identification marking, make sure original marking is replaced as in original.

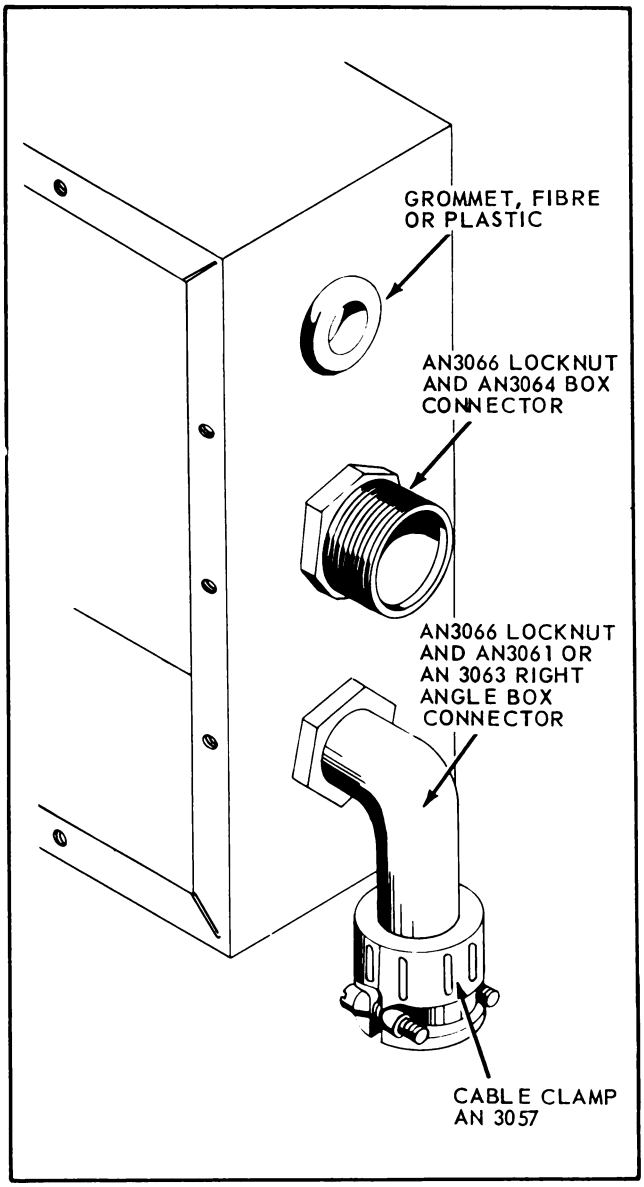


Figure 10–6. Wire Entry Holes in Junction Boxes

10-26. INSTALLATION OF PROTECTIVE DEVICES.

10-27. GENERAL. Protective devices are items of electrical equipment such as circuit breakers, fuses, etc.; installed in aircraft to protect the electrical system against overloads caused by short circuits or other faults.

10-28. MOUNTING HARDWARE. If attaching hardware is furnished with the protective device, use it. If no attaching hardware is furnished, mount the protective device with standard AN cadmium plated steel screws or bolts, of the appropriate size. When replacing a protective device, use hardware exactly the same as in the original installation except that a longer screw may be used if necessary.

CAUTION

Do not use self-tapping screws to mount protective devices.

10-29. MOUNTING WITH THROUGH BOLTS OR SCREWS. When possible attach protective devices to aircraft structure or other support with through bolts or screws. Install a plain washer under the head of the bolt or screw, and a plain washer and a split lock-washer under the nut. See Figure 10-7.

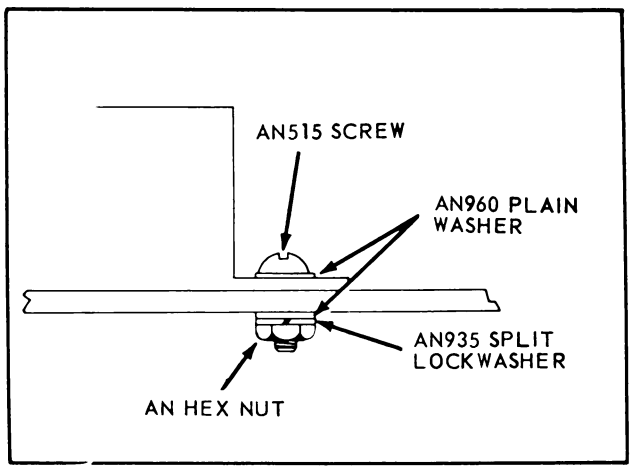


Figure 10–7. Mounting Protective Devices

10-30. MOUNTING INTO TAPPED HOLE OR NUT PLATE. When it is necessary to install a protective device with a screw into a tapped hole or a nut plate, install a plain washer and a split lock-washer under the screw or bolt head. See Figure 10-8.

10-31. MOUNTING INTO BLIND HOLE. When a protective device must be attached with a screw into a blind tapped hole, make sure that the screw will give maximum thread engagement without bottoming in the hole. The length is determined as follows: See Figure 10-9.

a. Select a screw of approximately the correct length and install a plain washer and lock washer on it.

NOTE

Do not mount the protective device when determining screw length.

b. Insert the screw into the blind tapped hole, and thread it in until it bottoms in the hole. Plain and lock washers should remain free.

c. Back out the screw two turns, and measure the length of screw between the under surface of the head and the top washer.

d. Measure the thickness of the mounting part of the protective device, and subtract it from the measurement obtained in Step c. If the device to be mounted is thicker than the dimension obtained in Step c, repeat from Step a, using a longer screw.

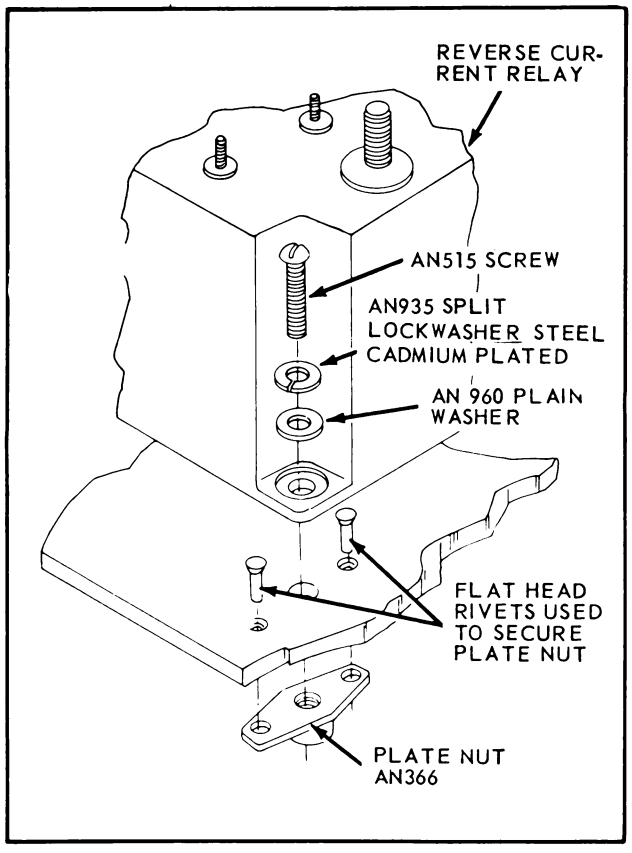


Figure 10–8. Typical Mounting Hardware for Electrical Devices

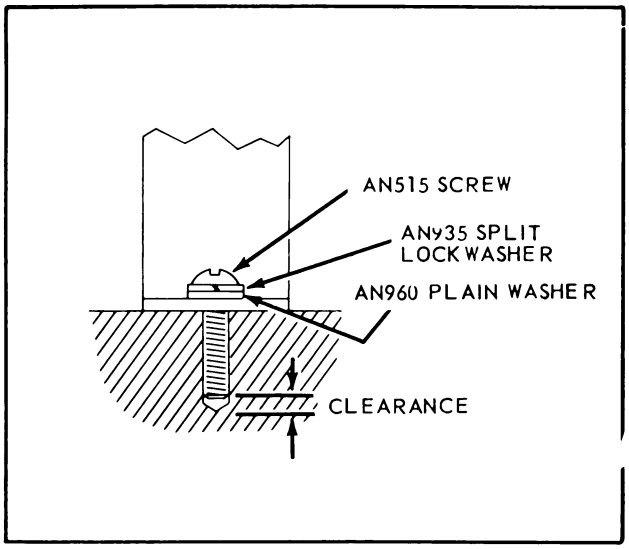


Figure 10–9. Determining Screw Length for Mounting Into Blind Holes

e. Subtract dimension obtained in Step d. from the overall length of the screw; this will give the maximum length which can be used without bottoming in the tapped hole. If the final length is not a standard length, use the next shorter standard screw.

10-32. MOUNTING CIRCUIT BREAKERS. Mount switch circuit breakers so that when the switch breaker is in the off, or open position, the handle will be down or to the rear.

10-33. MOUNTING RELAYS. Mount relays so that foreign particles cannot fall between the terminals, and so that liquid cannot accumulate inside the cover.

10-34. SPECIAL PRECAUTIONS FOR BONDING OR GROUNDING CONNECTIONS. When a bond or ground connection is made through the mating surfaces of structure and mounting pad, prepare the contacting surfaces as described in Section VII, paragraph 7-13, before attaching the device to structure.

10-35. PROTECTION. If possible mount protective devices in junction boxes or protected areas. If this is not possible, and the devices are to be installed in locations where they may be subject to damage or where the terminals may be dangerous to personnel, provide a cover to go over the protective device.

10-36. IDENTIFICATION. Make sure that each protective device is identified by a plate or decal, permanently attached to adjacent aircraft structure. If the location of a protective device is changed make sure that the identification marking is also relocated, and completely visible. Make sure the new identification marking is exactly the same as the original.

10-37. INSTALLATION OF TERMINAL STRIPS

10-38. GENERAL. Terminal strips are used in aircraft to provide junction points of good electrical conductivity for circuits which are not frequently disconnected.

10-39. MOUNTING HARDWARE. Use standard AN cadmium plated steel hardware of the appropriate size.

10-40. METHOD OF ATTACHMENT. Install mounting screws so that the screw protrudes through the bottom of the terminal strip, as shown in Figure 10-10. The length of the screw should allow for some protrusion beyond the nut. Pass a steel scale or other flat piece of metal over the top of the nut. If it passes over freely, the screw is too short, and is to be replaced with the next longer length. Protrusion of screw should not exceed 2 threads.

10-41. ALTERNATE METHOD OF ATTACHMENT. If it is not possible to install the mounting screw from the top of the terminal strip, install it from the back as shown in Figure 10-11. In this case, the end of the screw should project just beyond the top of the nut, but do not select a screw that will extend beyond the level of the terminal strip mounting surface.

10-42. INSULATION. See Figure 10-12. Place an insulating strip over each mounting screw, long enough so it will go over the two adjacent terminal studs under the washers and nut which secure each stud.

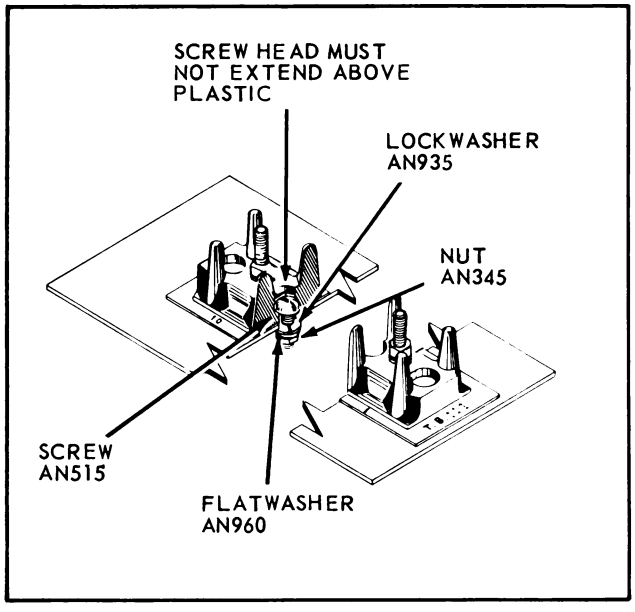


Figure 10–10. Mounting of Terminal Strips

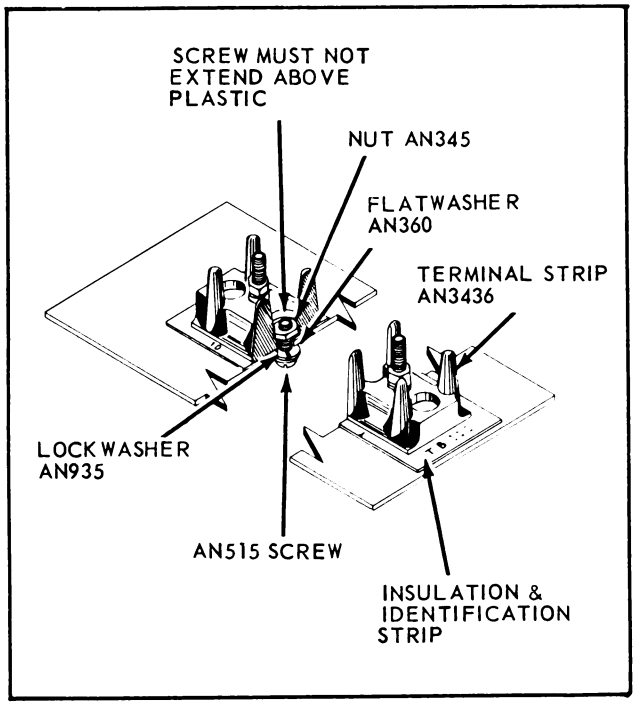


Figure 10–11. Alternate Mounting of Terminal Strips

10-43. ATTACHING BUSBAR TO TERMINAL STRIP. When a busbar is to be attached to a terminal, mount the busbar directly on top of the nut which holds the terminal stud in place. Terminal lugs are then installed on top of the busbar as described in Section XI, paragraph 11-30.

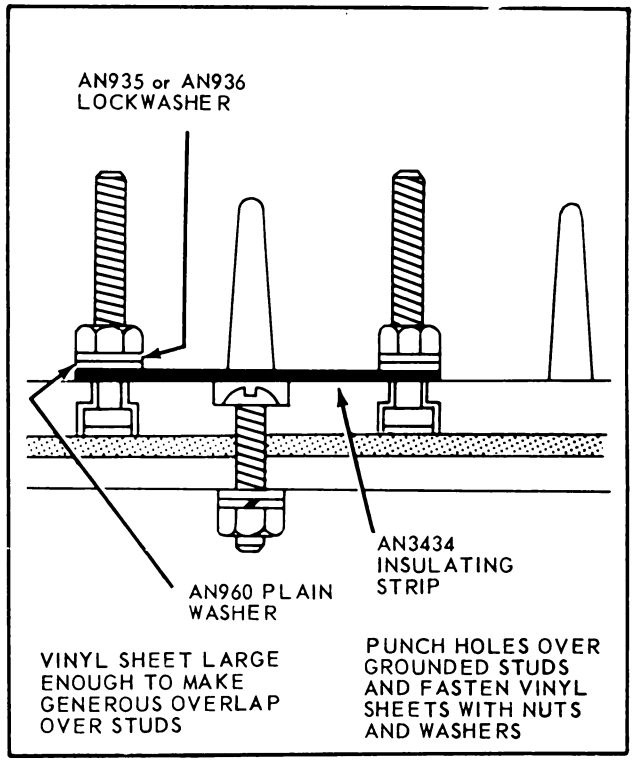


Figure 10–12. Insulation of Terminal Strip

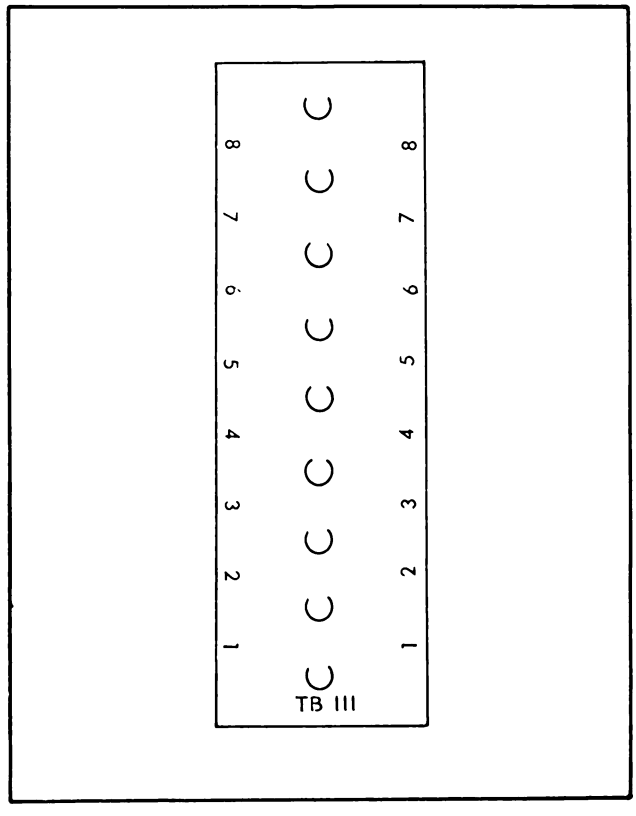


Figure 10–13. Identification of Terminal Strips

NOTE

If aluminum busbars are removed, and are to be replaced, examine the bus bar for deformation before replacing it. If there is any deformation, discard it, and install a new busbar.

10-44. PROTECTION. Where possible, mount terminal strips inside Junction boxes or other enclosures. If this is not possible, and the terminal strip is located where it may be damaged, or may be dangerous to personnel, provide a cover for it. See Figure 10-12, for illustration of cover.

10-45. IDENTIFICATION. See Figure 10-13. Terminal strips are identified by means of letters and numbers on the insulation strip installed behind the terminal strip. Each insulation strip bears the letters TB followed by the number of the individual terminal strip. Each terminal is identified by a number on the strip adjacent to the stud. When replacing damaged terminal strips do not remove the identifying insulation strip unless it also has been damaged. In this case replace the identification exactly as in the original. When a new terminal strip is installed, cement the insulating strip, with identification as given on the wiring diagram, to the structure before installing the terminal strip.

SECTION XI

ELECTRICAL WIRING INSTALLATION

11–1. INTRODUCTION.

11–2. SCOPE. This section describes the recommended procedures for installing electrical wiring and related accessories in military aircraft.

11–3. DEFINITIONS.

a. *Open Wiring.* Any wire, wire group or wire bundle not enclosed in conduit.

b. *Wire Group.* Two or more wires going to the same location, tied together to retain identity of the group.

c. *Wire Bundle.* Two or more wire groups, tied together because they are going in the same direction at the point where the tie is located.

d. *Electrically Protected Wiring.* Those wires which include in the circuit, protections against overloading such as fuses, circuit breakers or other limiting devices.

e. *Electrically Unprotected Wiring.* Those wires (generally from generators to main bus distribution points) which do not have protection such as fuses, circuit breakers or other current limiting devices.

11–4. REFERENCE SPECIFICATIONS.

MIL-W-5088 Wiring, Aircraft, Installation of
MIL-S-8516 Sealing Compound, Synthetic Rubber, Accelerated

11–5. WIRE TYPES. The most commonly used aircraft wires are in accordance with the following six specifications:

11–6. WIRE GROUPS AND BUNDLES.

11–7. WIRE SEPARATION. MIL-W-5088 restricts the grouping or bundling of certain wires such as electrically unprotected power wiring and wiring to duplicate vital equipment. Do not add such wires to existing bundles unless specifically authorized.

11–8. SIZE OF WIRE BUNDLE. Military specifications generally limit the size of a wire bundle to 75 wires, or 1-1/2 inches diameter, whichever is smaller.

11–9. IDENTITY OF GROUPS WITHIN BUNDLES. When several wires are grouped at junction boxes, terminal blocks, panels, etc., retain the identity of the group within a bundle by spot ties, as shown in Figure 11–1.

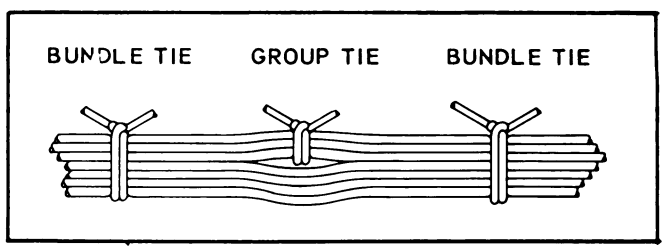


Figure 11–1. Group and Bundle Ties

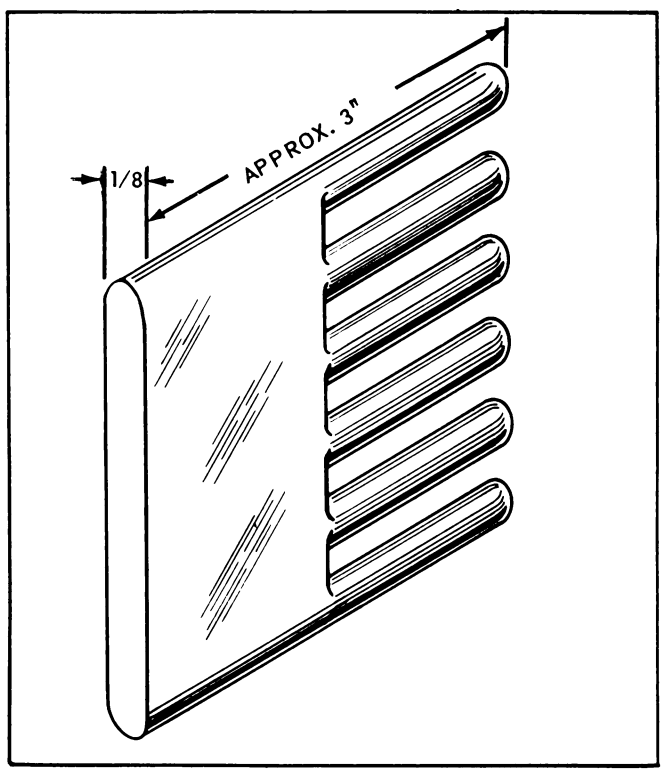


Figure 11–2. Comb for Straightening Wires in Bundles

TABLE LXXIX
Wire Types

Specification	*Conductor*	*Max. Voltage*	*Max. Temp.* ^{o}C	^{o}F
MIL-W-5086	Copper, Tinned	600	93	200
MIL-W-5274 (USAF)	Copper, Tinned	1000	93	200
MIL-W-7072	Aluminum	600	93	200
MIL-W-7139	Copper, Silvered	600	204	400
MIL-W-8777 (USAF)	Copper	600	150	302
32659 (USAF)	Copper, Nickeled	600	343	650

11–10. COMBING WIRES. Comb out all wires, except those listed in paragraph 11–11, so that wires will be parallel to each other in group or bundle. A useful tool for combing out wires is shown in Figure 11–2.

Make this tool from a piece of 1/8 inch nylon or other smooth insulating material. Be sure all sharp edges are rounded to protect wire insulation.

11–11. TWISTING WIRES. When specified on applicable engineering drawings, twist together the following wires:

a. Wiring in vicinity of magnetic compass or flux valve.
b. Three-phase distribution wiring.
c. Certain other wires (usually radio wiring) as specified on engineering drawings.

Twist wires so they lie snugly against each other, making approximately the number of twists as listed in Table XXC. Check wire insulation for damage after twisting. If insulation is torn or frayed, replace the wire.

TABLE XXC

Twists Per Foot

Wire Size	*#22*	*#20*	*#18*	*#16*	*#14*	*#12*	*#10*	*#8*	*#6*	*#4*
2 Wires	10	10	9	8	7½	7	6½	6	5	4
3 Wires	10	10	8½	7	6½	6	5½	5	4	3

11–12. SPLICED CONNECTIONS IN BUNDLES. Locate spliced connections in wire groups or bundles so that they can be inspected. Stagger splices so that the bundle does not become excessively enlarged, as shown in Figure 11–3.

Make sure that all non-insulated splices are covered with plastic sleeves, securely tied at both ends.

11–13. SLACK Do not install single wires or wire bundles with excessive slack. Slack between support points, such as MS 21919 cable clamps, should normally not exceed 1/2 inch. This is the maximum that it should be possible to deflect the wire with normal hand force. This may be exceeded if the wire bundle is thin and the clamps are far apart. But the slack must never be so large that the wire bundle can touch any surface against which it may abrade. See Figure 11–4 for slack illustration. Allow a sufficient amount of slack near each end for any or all of the following:

a. To permit easy maintenance.
b. To allow replacement of terminals, twice.
c. To prevent mechanical strain on the wires, wire junctions and supports.
d. To permit free movement of shock- and vibration-mounted equipment.
e. To permit shifting of equipment for purposes of maintenance.

11–14. BEND RADII. Bend individual wires, in wire bundles to a minimum radius of ten times the outside diameter of the wire or bundle, except at terminal strips, where wire is suitably supported at each end of bend, a minimum radius of three times the outside diameter of the wire, or wire bundle is acceptable.

CAUTION

Never bend coaxial cable to a smaller radius than 6 times the outside diameter.

When it is not possible to hold the bending radius of single wires to the above limits, enclose wire in tight

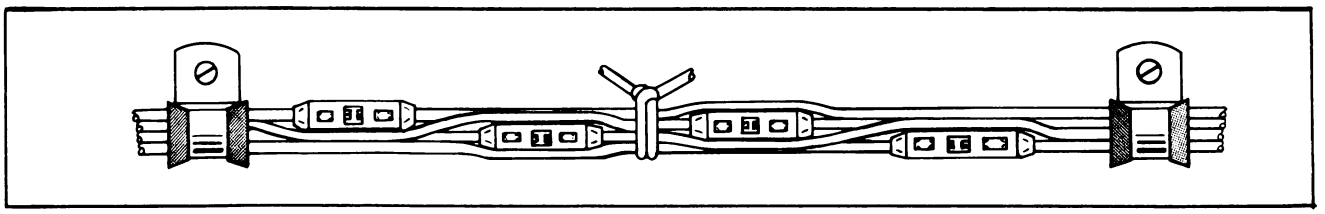


Figure 11–3. Staggered Splices in Wire Bundle

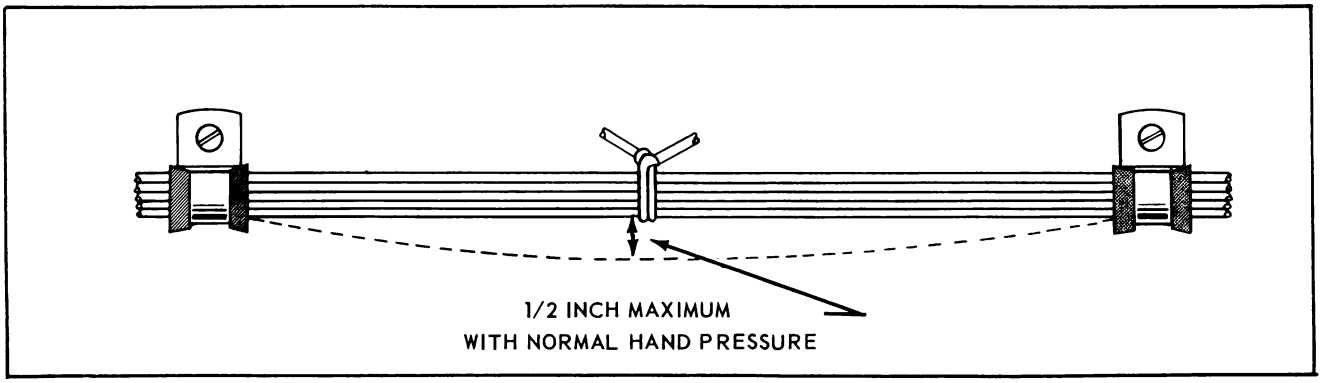


Figure 11–4. Slack Between Supports

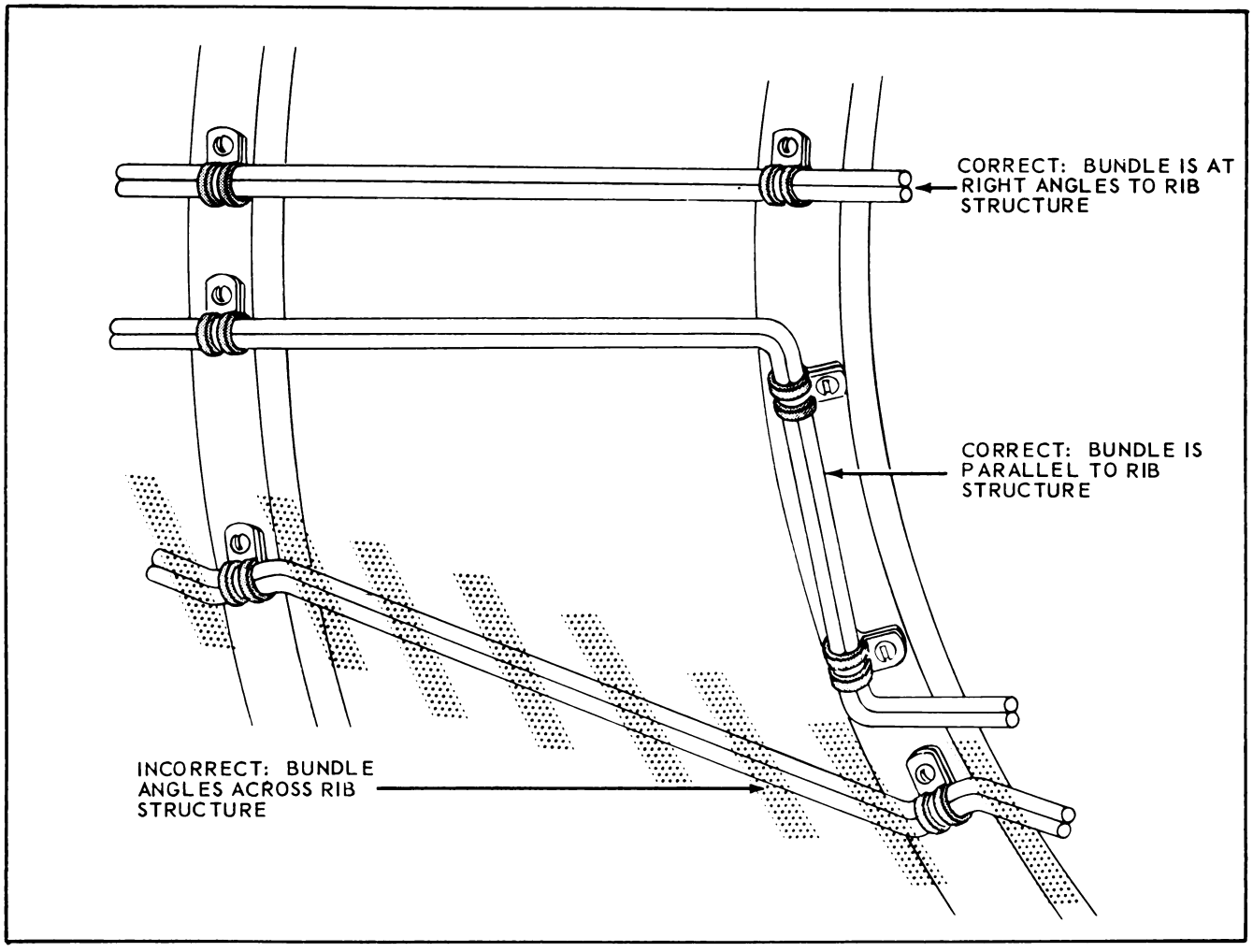


Figure 11–5. Routing Bundles

plastic tubing for at least two inches each side of the bend.

11–15. ROUTING AND INSTALLATION INSTRUCTIONS.

11–16. GENERAL ROUTING INSTRUCTIONS. Install all wiring so it is mechanically and electrically sound and neat in appearance. Wherever practicable, route wires and bundles parallel with, or at right angles to the stringers or ribs of the area involved.

NOTE

Route coaxial cables as directly as possible. Avoid unnecessary bends in coaxial cable.

In general, locate attachments at each frame rib on runs along the length of the fuselage, or at each stiffener on runs through the wings. Install and route all wires and wire groups so as to protect them from the following:

a. Chafing or abrasion.

b. High temperature.

c. Use as handholds, or as support for personal belongings and equipment.

d. Damage by personnel moving within the aircraft.

e. Damage from cargo stowage or shifting.

f. Damage from battery acid fumes, spray, or spillage.

g. Damage from solvents and fluids.

h. Abrasion in wheel wells where exposed to rocks, ice, mud, etc.

11–17. PROTECTION AGAINST CHAFING. Install wires and wire groups so they are protected against chafing or abrasion in those locations where contact with sharp surfaces or other wires would damage the insulation. Damage to the insulation may result in short circuits, malfunction or inadvertant operation of equipment. Use MS 21919 cable clamps to support wire bundles at each hole through a bulkhead. See Figure 11–6. If wires come closer than 1/4 inch to edge of hole also use a suitable grommet in hole as shown in Figure 11–7.

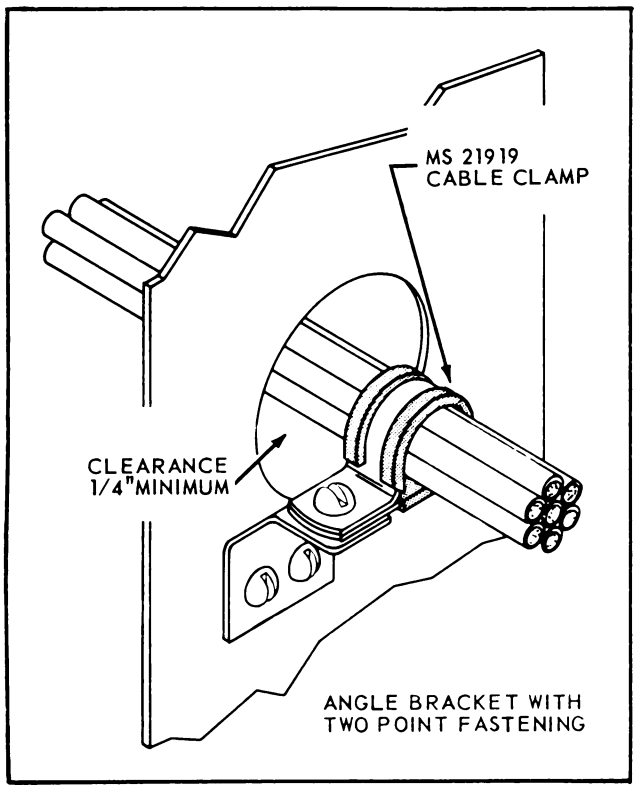


Figure 11–6. Cable Clamp at Bulkhead Hole

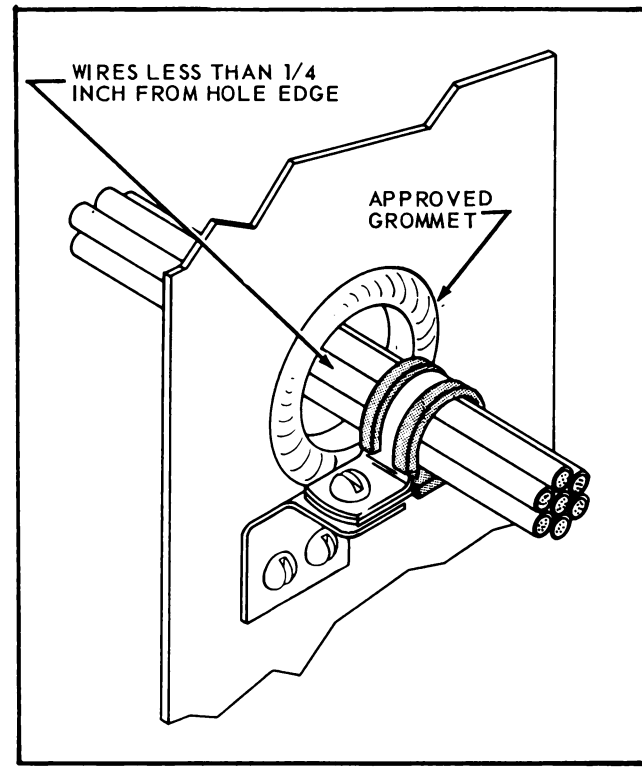


Figure 11–7. Cable Clamp and Grommet at Bulkhead Hole

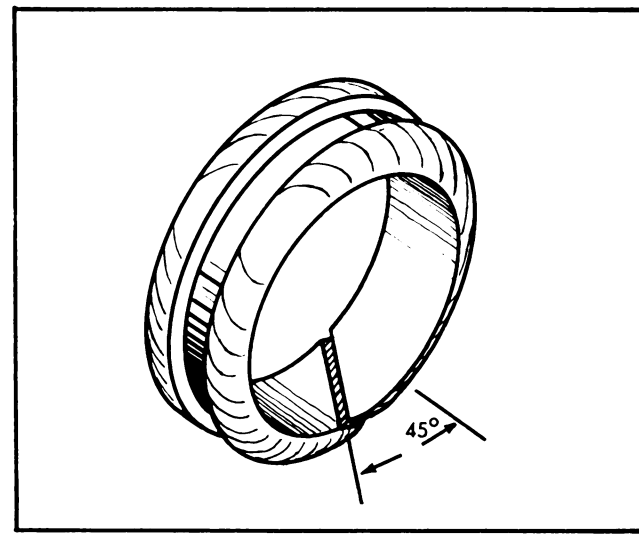


Figure 11–8. Split Grommet

11–18. Sometimes it is necessary to cut nylon grommets to facilitate installation. In these instances, after insertion, secure the grommet in place with general purpose cement. The slot must be at the top of the hole. Make the cut at an angle of 45° to the axis of the wire bundle hole as shown in Figure 11–8.

11–19. PROTECTION AGAINST HIGH TEMPERATURE. To prevent wire insulation deterioration, keep wires separate from high temperature equipment, such as resistors, exhaust stacks, heating ducts, etc. The amount of separation is specified, by engineering drawings. Some wires must invariably be run through hot areas. These wires must be insulated with high temperature material such as asbestos, fiber glass, or teflon. Additional protection is also often required in the form of conduits as specified by engineering.

CAUTION

Never use a low temperature insulated wire to replace a high temperature insulated wire.

Many coaxial cables have soft plastic insulation such as polyethylene. These are especially subject to deformation and deterioration at elevated temperatures. Avoid all high temperature areas with these cables.

11–20. Give additional abrasion protection to asbestos wires enclosed in conduit. Either use conduit with a high temperature rubber liner or enclose asbestos wires individually in high temperature plastic tubes before installing in conduit.

11–21. PROTECTION AGAINST PERSONNEL AND CARGO. Install wire bundles so they are protected by the structure. Use structure or conduit to prevent pinching against the air frame by cargo. Also place the bundles so that personnel are not tempted to use sections of wire runs as hand holds or ladder rungs.

11–22. PROTECTION AGAINST BATTERY ACIDS. Never route any wires below a battery. Inspect wires in battery areas frequently. Replace any wires which are discolored by battery fumes.

11–23. PROTECTION AGAINST SOLVENTS AND FLUIDS. Avoid areas where wires will be subjected to damage from fluids. Do not place any wires in the lowest six inches (bilge) of the fuselage. If there is a possibility that wire without a protective nylon outer jacket may be soaked in any other location, use plastic tubing to protect it. This tubing should extend past the wet area in both directions and be tied at each end if the wire has a low point between the tubing ends. The lowest point of the tubing should have a 1/8 inch drainage hole as shown in Figure 11–9. This hole should be punched into the tubing after the installation is complete and the low point definitely established. Use a hole punch to cut a half circle. Be careful not to damage any wires inside the tubing when using the punch.

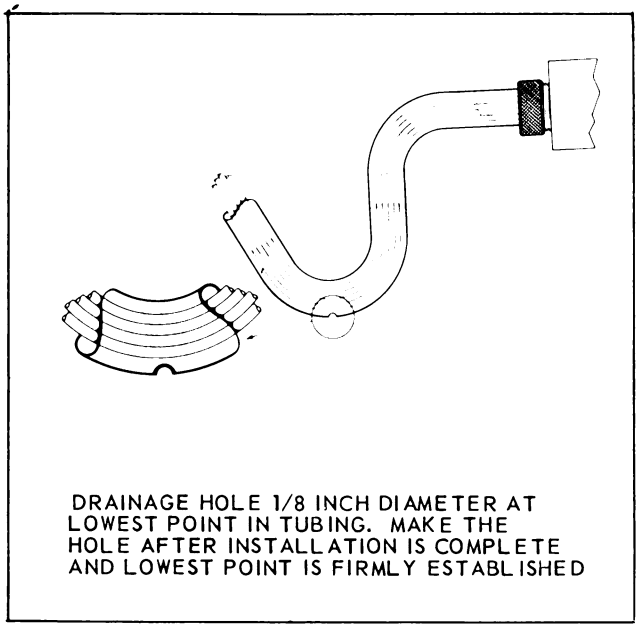


Figure 11–9. Drainage Hole in Low Point of Tubing

11–24. PROTECTION IN WHEEL WELLS AND WING FOLDS. Wires located in wheel wells and wing folds are subject to many additional hazards such as exposure to fluids, pinching, and severe flexing in service. Be sure that all wire bundles are protected by sleeves of flexible tubing securely held at each end. There should be no relative movement at point where flexible tubing is secured. Inspect these wires and the insulating tubing carefully at very frequent intervals. (See applicable Handbook of Maintenance Instructions for frequency of inspection.) Replace wires and or tubing at the first sign of wear. There should be no strain on attachments when parts are fully extended but slack should not be excessive.

11–25. ROUTING PRECAUTIONS. When wiring must be routed parallel to combustible fluid or oxygen lines for short distances, maintain as much fixed separation as possible; 6 inches or more. Route the wires on a level with, or above, the plumbing lines. Clamps should be spaced in such a manner that if a wire is broken at a clamp it will not contact the line. Where a six-inch separation is not possible, clamp both the wire bundle and the plumbing line to the same structure to prevent any relative motion. If the separation is less than 2 inches but more than 1/2 inch use a nylon sleeve over the wire bundle to give further protection. Also use two cable clamps back to back as shown in Figure 11–10 to maintain a rigid separation only and not for support of the bundle.

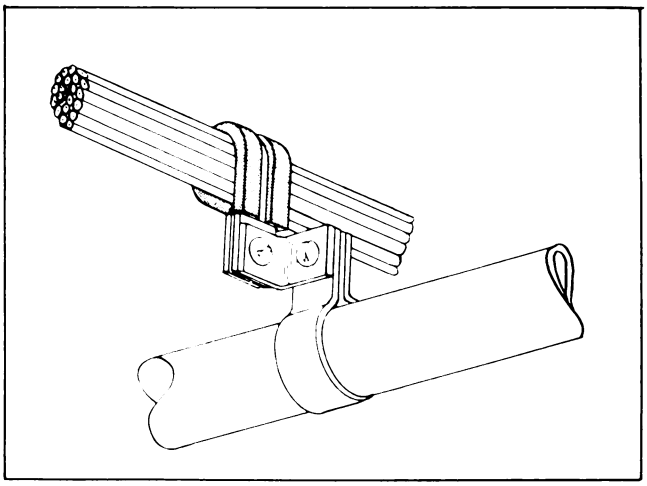


Figure 11–10. Separation of Wires from Plumbing Lines

CAUTION

Do not route any wire so that it can possibly come closer than 1/2 inch from a plumbing line.

WARNING

Never support any wire or wire bundle from a plumbing line carrying *flammable fluids* or *oxygen.*

11–26. Route wiring to maintain a minimum clearance of three inches from control cables. If this cannot be done, install mechanical guards to prevent contact of wiring with control cables.

11–27. INSTALLATION OF CABLE CLAMPS. Install MS-21919 cable clamps as shown in Figure 11–11. The mounting screw must be above the wire bundle. It is also desirable that the back of the cable clamp rest against a structural member if practicable. Use hardware as shown in Figure 11–12 to mount cable clamps to structure. Be careful not to pinch wires in cable clamp.

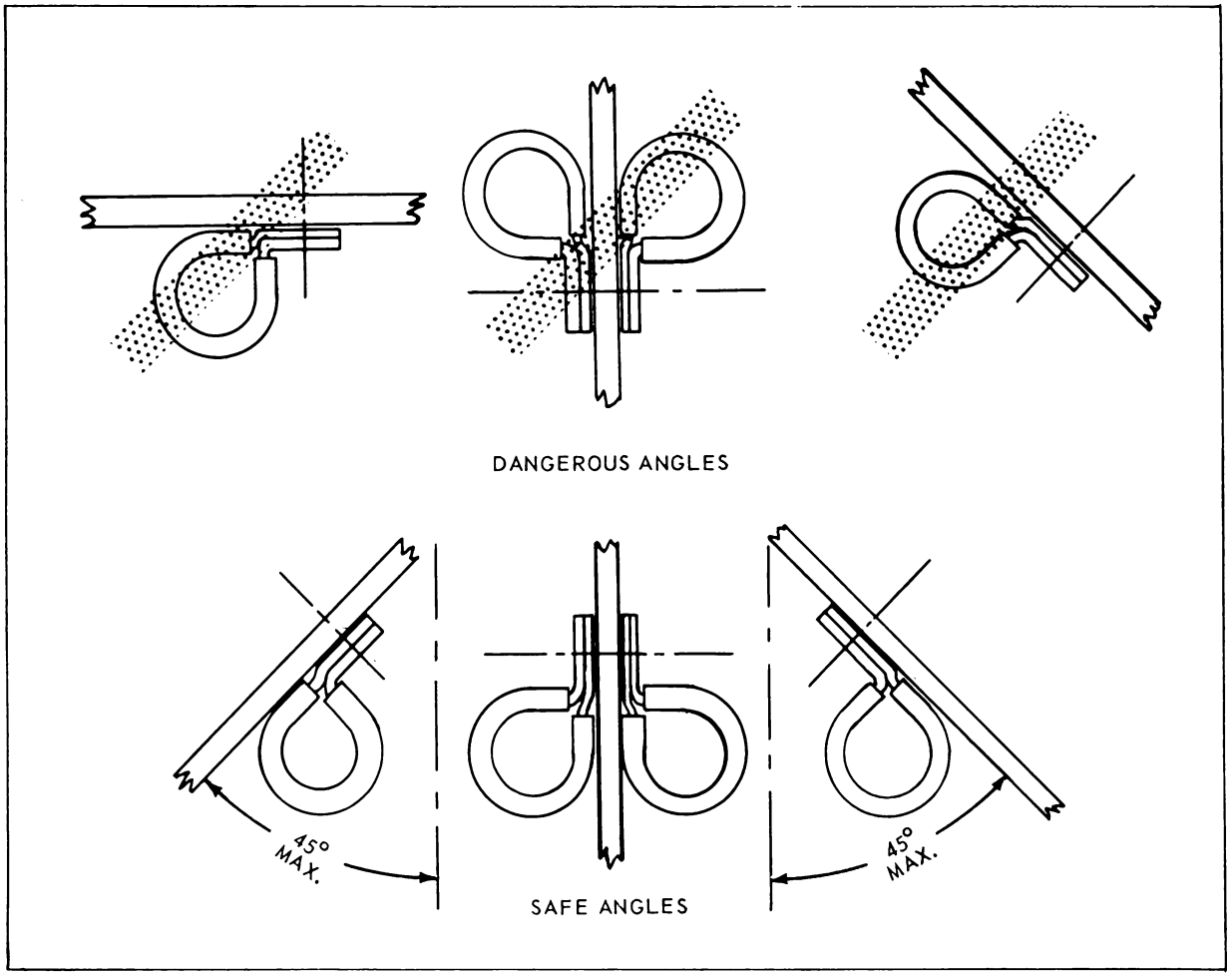


Figure 11–11. Safe Angle for Cable Clamps

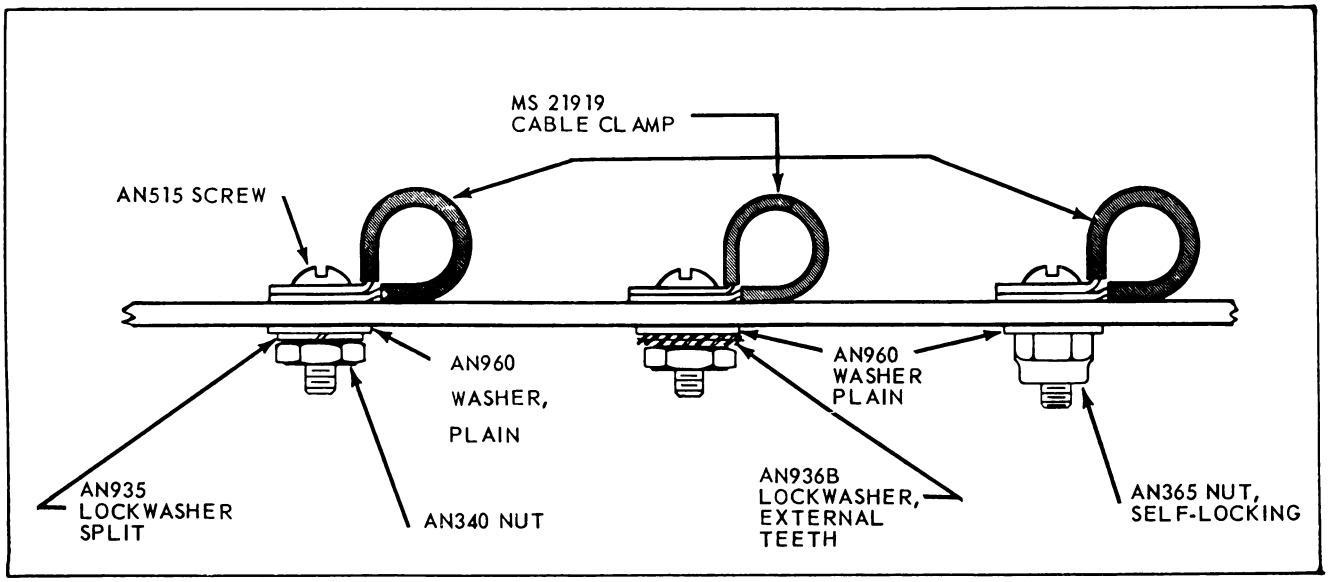


Figure 11–12. Typical Mounting Hardware for MS 21919 Cable Clamps

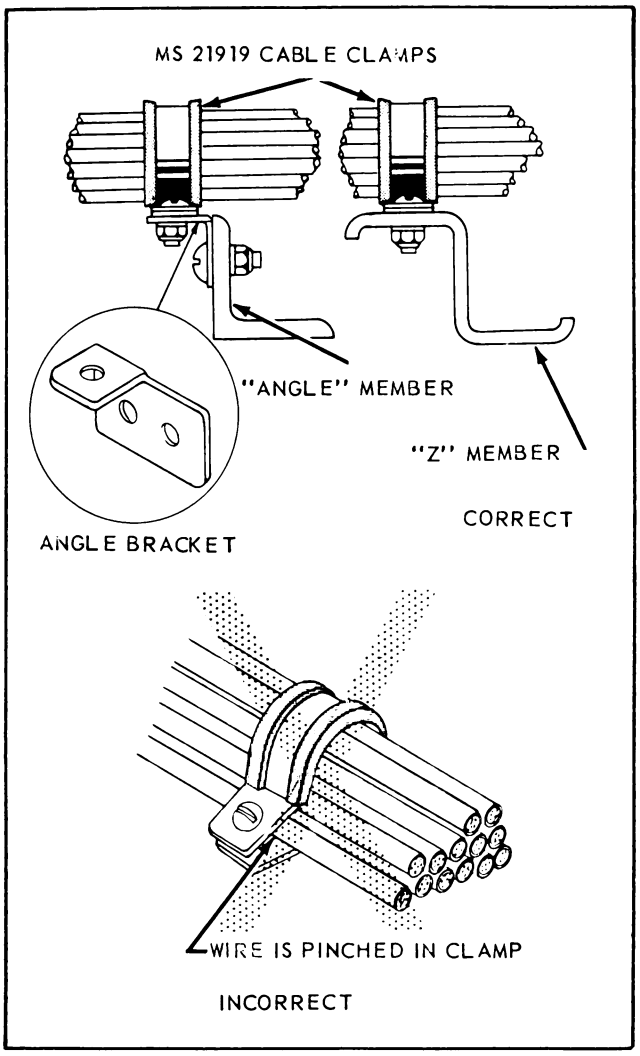


Figure 11–13. Installing Cable Clamp to Structure

NOTE

MS21919 cable clamps are cushioned with insulating material to prevent abrasion of wires. Never use clamps without cushions to hold wires.

11–28. Mount cable clamps directly to "Z" members of structure. Use angle bracket with two mounting screws if structural member is "angle" as shown in Figure 11–13.

11–29. INSTALLING CABLE CLAMPS TO TUBULAR STRUCTURE. Use AN735 clamps without cushions to clamp to tubular structure. This clamp must fit tightly but should not deform when locked in place. Attach wire bundle in MS21919 cable clamp to the AN735 clamp with AN hardware as shown in Figure 11–14.

11–30. CONNECTING TERMINAL LUGS TO TERMINAL BLOCKS. Install terminal lugs to AN3436 terminal blocks in such a manner that they are locked against movement in the direction of loosening. See Figure 11–15 for means of preventing loosening.

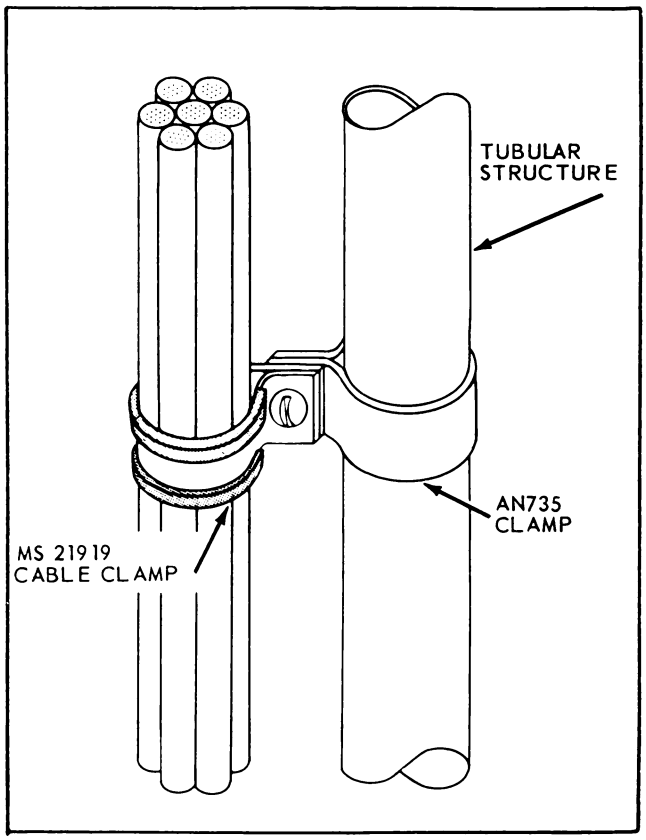


Figure 11–14. Installing Cable Clamps to Tubular Structure

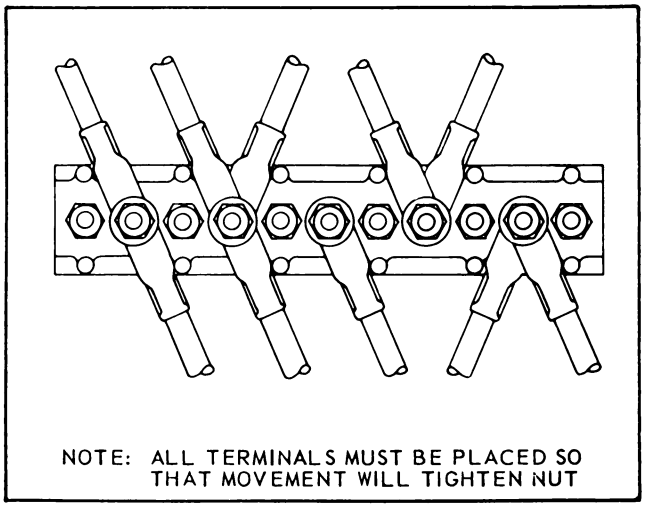


Figure 11–15. Connecting Terminals to Terminal Block

11–31. HARDWARE FOR WIRING TERMINAL BLOCKS. AN3436 terminal blocks are supplied with studs secured in place by means of an AN961 plain washer, an AN936B external tooth lockwasher and an AN341 nut.

11–32. Place COPPER terminal lugs directly on top of the AN 341 nut. Follow with AN960 plain washer, AN 935 split steel lockwasher and AN340 plain nut or AN365 self-locking, all metal, nut. See Figure 11–16 for details of these assemblies.

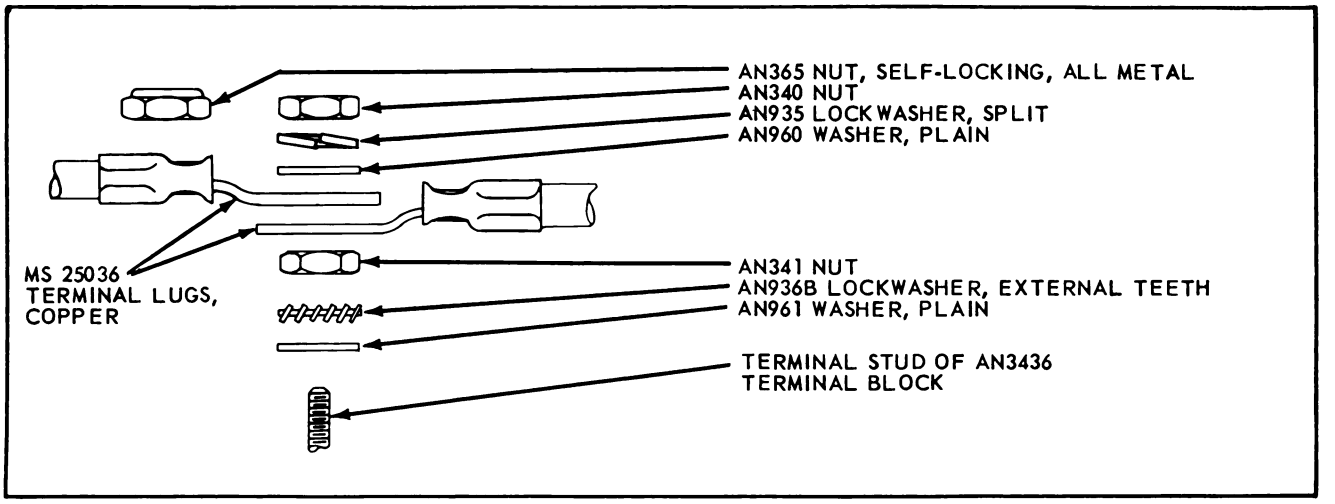


Figure 11–16. Hardware for Wiring Terminal Blocks With Copper Terminals

NOTE

Do *not* eliminate the AN935 split steel lockwasher even when using an AN365 self-locking nut.

11–33. Place ALUMINUM terminal lugs over a plated brass plain washer. Follow the terminal lugs with another plated brass plain washer, AN935 split steel lockwasher and AN340 plain nut or AN365 self-locking, all metal, nut. The plated brass washer must have a diameter equal to the tongue width of the aluminum terminal lug. See Table XXCI for dimensions of these plated brass washers. See Figure 11–17 for details of assembling aluminum terminal lugs to terminal blocks.

CAUTION

Do *not* place *any* washer in the current path between two ALUMINUM terminal lugs or between two COPPER terminal lugs.

TABLE XXCI

Special Plated Brass Washers

Stud Size	*Minimum O.D.*	*Thickness*	*Gen. Stores Stock Number*
#10	7/16	.045-.064	G43-W-3000
1/4	1/2	.045-.064	G43-W-3004
5/6	5/8	.051-.072	G43-W-3008
3/8	3/4	.057-.081	G43-W-3012
1/2	1	.064-.094	G43-W-3016

CAUTION

Never place a lockwasher directly against the tongue or pad of an aluminum terminal or busbar.

11–34. To join a COPPER terminal lug to an ALUMINUM terminal lug, place a plated brass plain washer over the nut which holds the stud in place: follow with the ALUMINUM terminal lug, a plated brass plain washer, the COPPER terminal lug, AN960 plain wash-

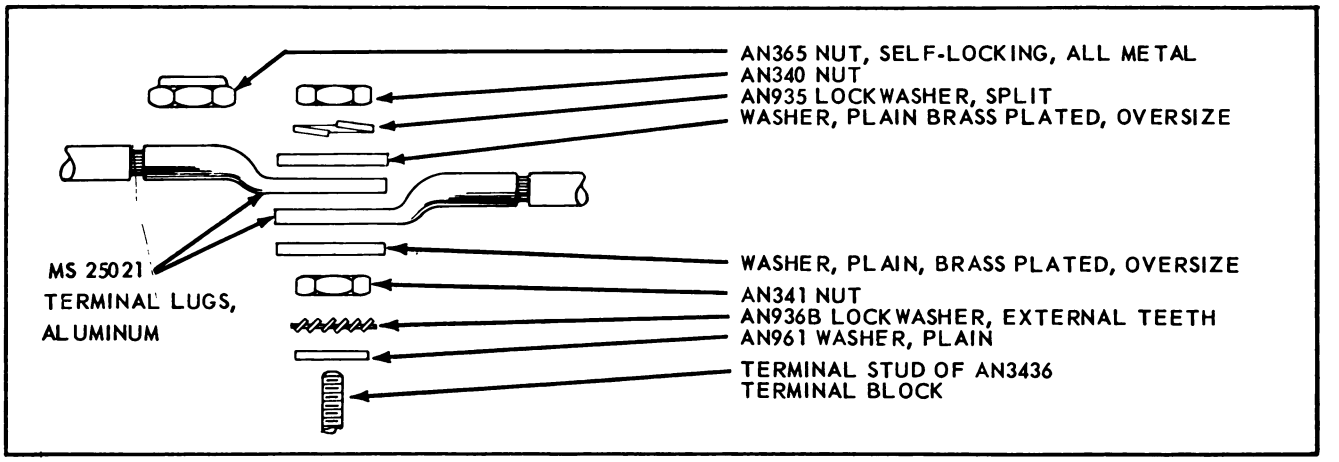


Figure 11–17. Hardware for Wiring Terminal Blocks With Aluminum Terminals

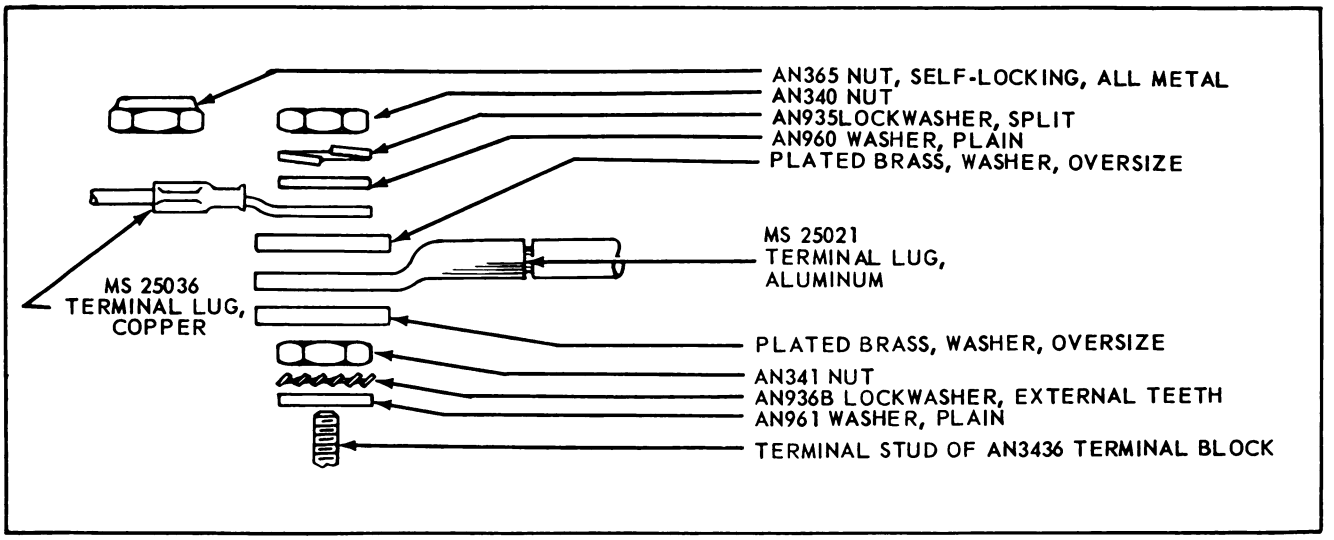


Figure 11-18. Hardware for Wiring Terminal Blocks With Combination of Terminals

er, AN935 split steel lockwasher and AN340 plain nut or AN365 self-locking, all metal, nut. See Figure 11-18 for details.

11-35. INSTALLATION TORQUES FOR LARGE COPPER TERMINALS. Use a torque wrench to tighten nuts on 3/8" and larger diameter studs to insure sufficient contact pressure. The tightening torques for plated steel studs are as listed in Table XXCII.

TABLE XXCII

Installation Torques for Copper Terminals

inch-pounds

Stud Size	*Plain Nuts*	*Self-locking Nuts*
3/8 - 24	110 - 120	115 - 125
1/2 - 20	135 - 150	150 - 170

11-36. INSTALLATION TORQUES FOR ALUMINUM TERMINALS. Use a torque wrench to tighten nuts over any "stack up" containing an ALUMINUM terminal lug. The tightening torques for plated steel studs are listed in Table XXCIII.

TABLE XXCIII

Installation Torques for Aluminum Terminals

inch-pounds

Stud Size	*Plain Nuts*	*Self-locking Nuts*
10 - 32	28 - 35	33 - 40
1/4 - 28	70 - 85	75 - 90
5/16 - 24	125 - 155	135 - 165
3/8 - 24	180 - 210	220 - 250
1/2 - 20	380 - 440	430 - 490

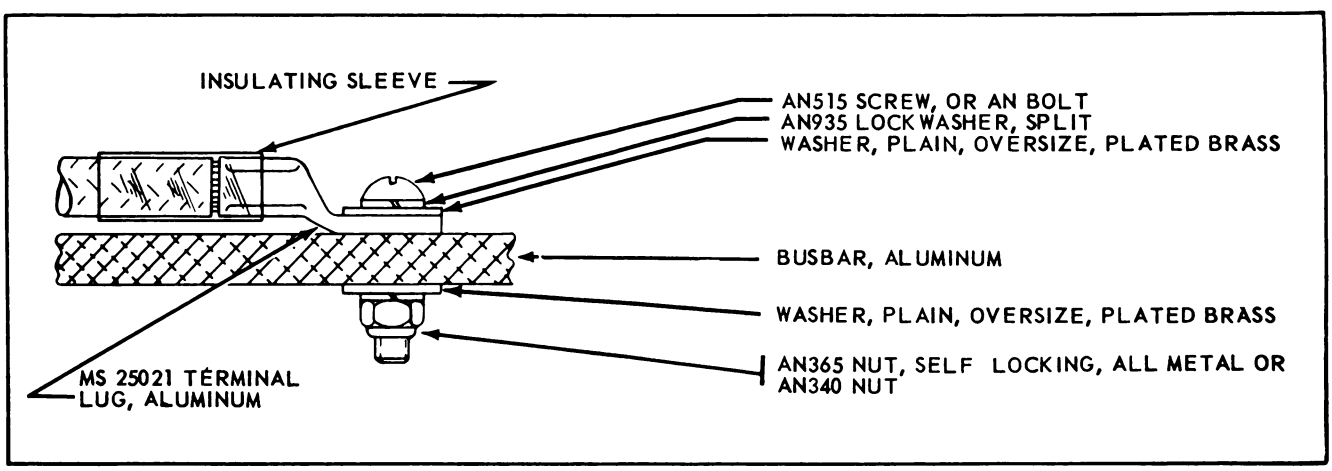


Figure 11-19. Connecting Aluminum Terminal to Aluminum Busbar

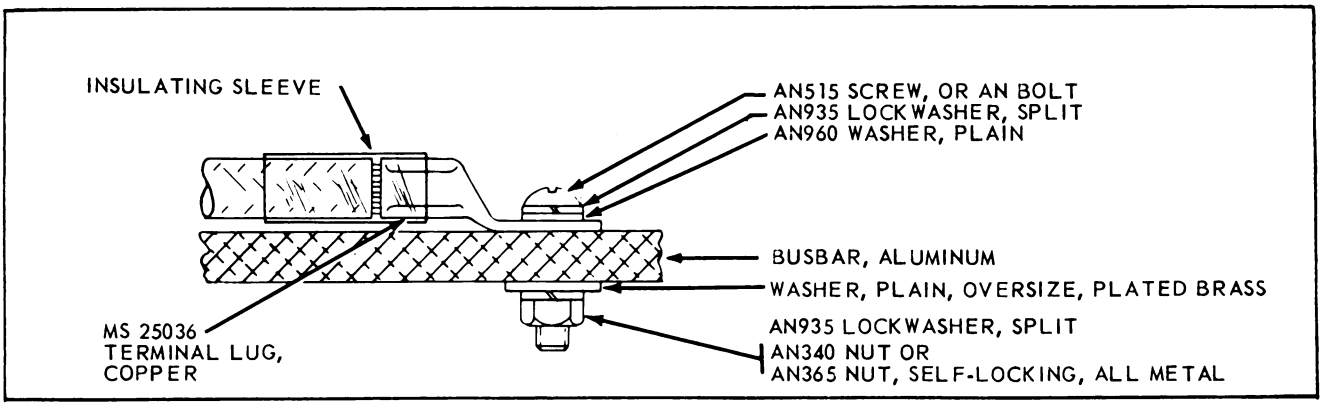


Figure 11–20. Connecting Copper Terminal to Aluminum Busbar

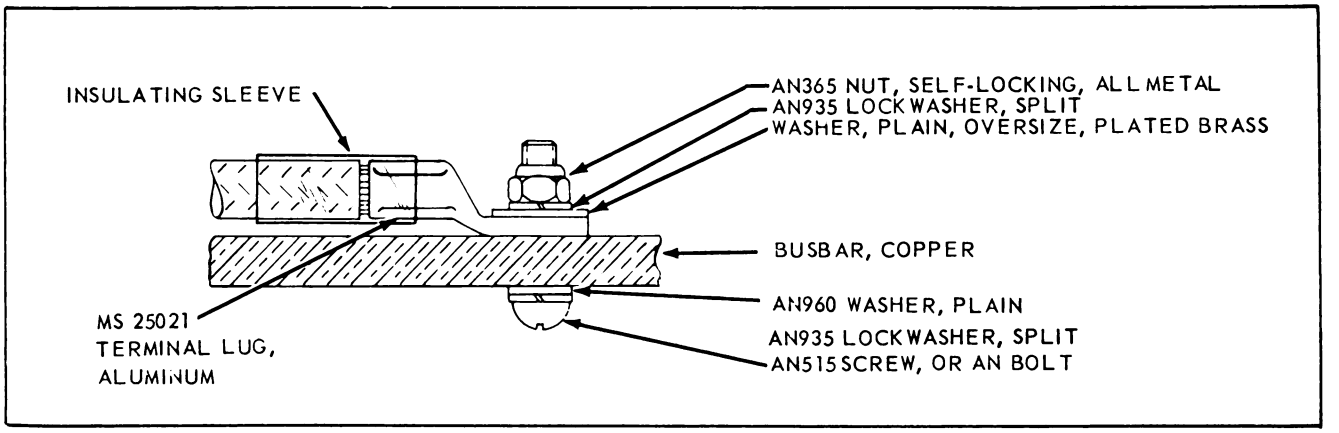


Figure 11–21. Connecting Aluminum Terminal to Copper Busbar

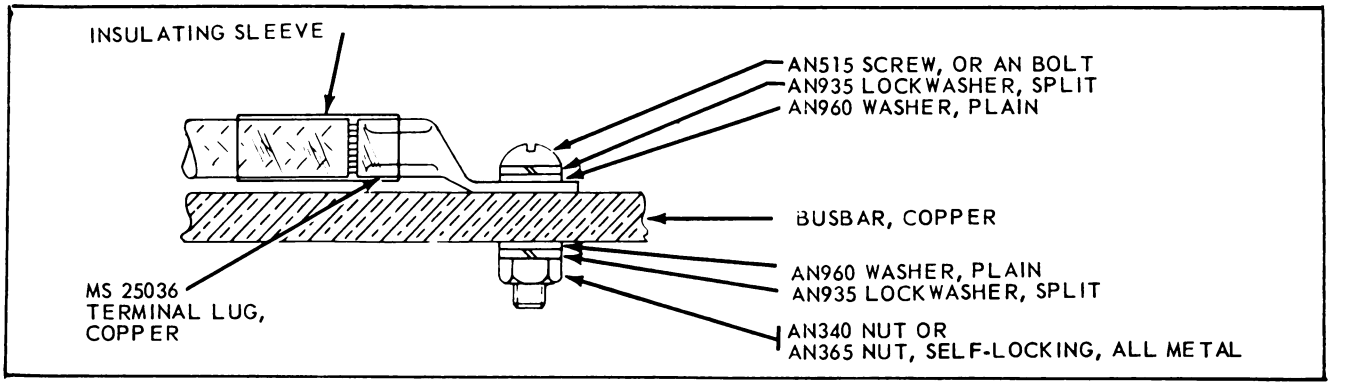


Figure 11–22. Connecting Copper Terminal to Copper Busbar

11–37. CONNECTING TERMINAL LUGS TO BUSBARS. In order to obtain maximum efficiency in the transfer of power, the terminal lug and the busbar are always in direct contact with each other, so that the current does not have to go through any of the attaching parts, even if these are good-current-carrying materials. As illustrated in Figures 11–19 through 11–22 the above applies whether the terminal lug and the busbar are of the same or of different materials.

11–38. CLEANING BUSBARS WHEN MAKING CONNECTIONS. Clean all busbar areas before making new connections or replacing old connections. See Section VIII – Busbar Preparation – for procedures to be followed in cleaning busbars. As noted in Section VIII, the cleaned surface of an ALUMINUM busbar is coated with a petrolatum-zinc dust compound which is left in place while the connection is made.

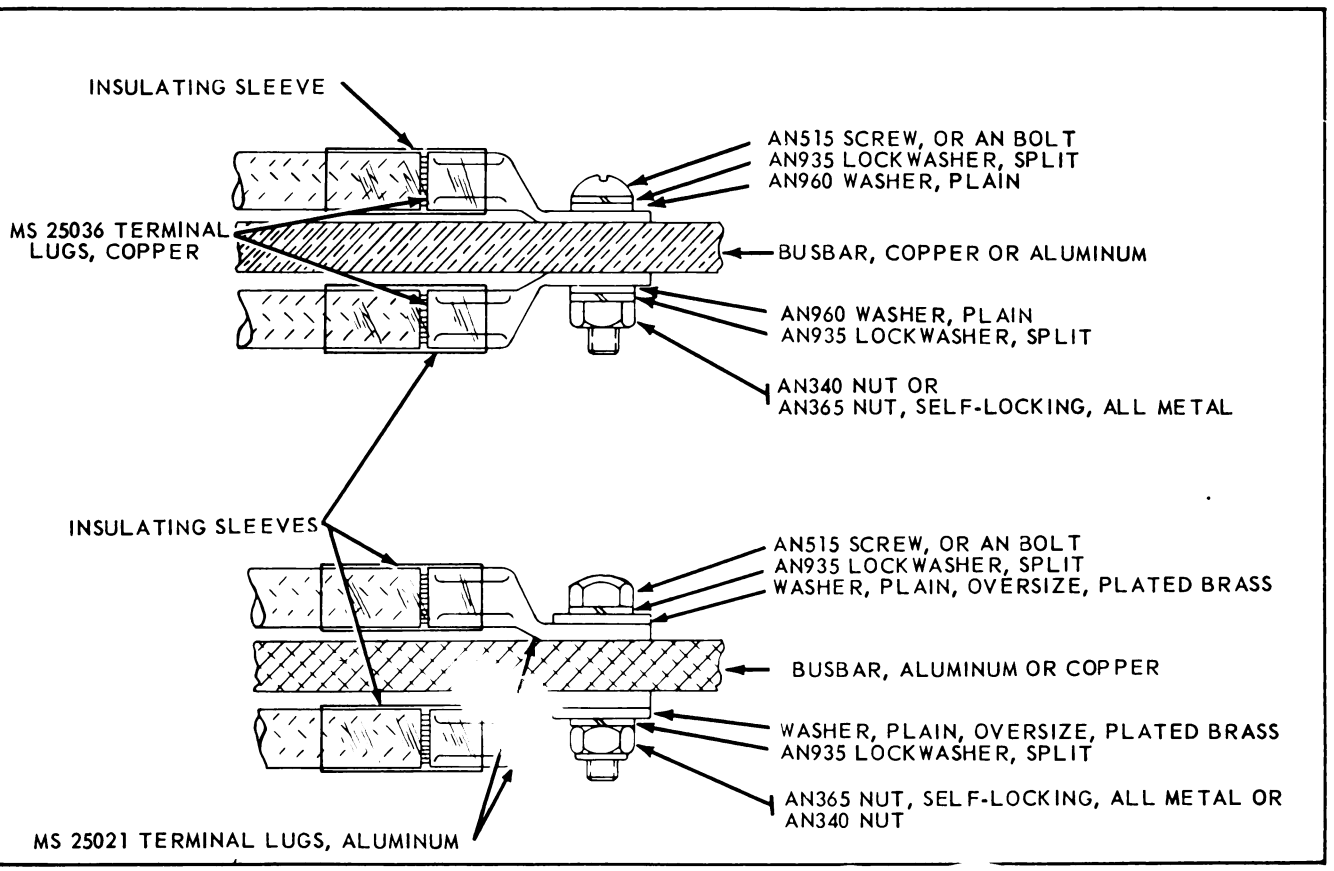


Figure 11–23. Connecting Two Terminals to Same Point on Busbar

1–39. HARDWARE FOR CONNECTION TO BUSBARS. AN *cadmium* plated steel hardware (except as noted below) is used to secure terminals to busbars. Use split lockwashers under hex nuts and under self-locking nuts. Use plated steel plain washers between lockwashers and copper busbars. Use plated brass plain washers between lockwashers and aluminum busbars. As shown in Figures 11–19 through 11–22, the head of the screw or bolt can be located on the terminal side or the busbar side as required to simplify the installation.

1–40. Use a cadmium plated, steel, split, lockwasher (AN 935) under the head of every bolt or screw and also under the nut, as shown.

1–41. Use plated brass plain washers in contact with aluminum. The plain washer diameter must be at least equal to the torque diameter of the terminal. See Table XXCI. Do not select a plated brass washer so large that it will ride on the barrel of the terminal. After tightening connection use soft cloth to wipe off excess petrolatum – zinc compound left in place in accordance with paragraph 11–38.

11–42. PRECAUTIONS WHEN REPLACING EXISTING CONNECTIONS. Observe the following precautions when replacing existing terminal lug connections to busbars.

a. Check all plain washers. Replace bent washers. Replace washers which have scratched plating or paint on fraying surface.

b. Clean busbars connection areas by approved methods. See Section VIII – Busbar Preparation.

c. Check plated copper terminal lugs before connecting to an aluminum busbar. If plating is scratched, replace terminal lug.

11–43. CONNECTING TWO TERMINALS TO SAME POINT ON BUSBAR. See Figure 11–23. Terminal lugs must always be in direct contact with busbar. As shown in Figure 11–23, connect one terminal lug to top of busbar and the other to bottom.

NOTE

Terminal lug offset is positioned so that barrel cannot contact busbar. This allows proper seating of tongue on busbar.

11–44. PROTECTION OF BUSBARS AGAINST ACCIDENTAL SHORTING. Busbars are usually enclosed in panels or junction boxes to protect them against accidental shorting. If the busbars are not enclosed it is desirable to use some protective coating. A good protective coating which is easily applied is MIL-S-8516 Sealing Compound. This is applied thickly with a spatula or short bristled brush to the cleaned busbar

prior to assembly of connections. Mask all areas where connections will be made. Use pressure sensitive tape for masking. See detailed instructions for cleaning area, preparing sealing compound and curing sealing compound in Section III, paragraphs 3-67 through 3-72. Remove masking tape, after sealing compound is cured, by cutting into compound next to tape with a razor blade and then peeling tape from the masked area.

11-45. Busbars can also be protected by slitting a piece of vinyl tubing and wrapping it around the busbar after all connections are made. Select vinyl tubing which has large enough diameter to permit a generous overlap when tying it in place. See Figure 11-24 for cutting and tying details.

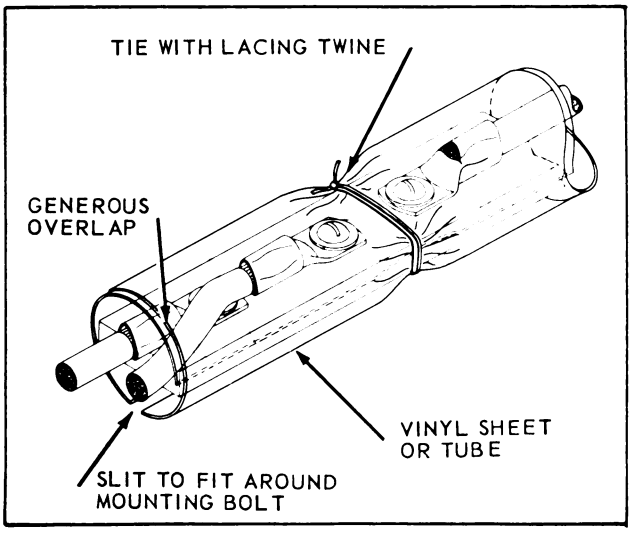


Figure 11-24. Vinyl Tubing Around Busbar

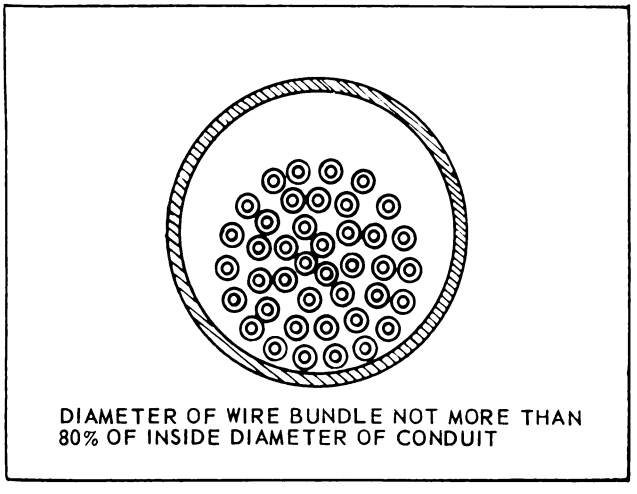


Figure 11-25. Conduit Capacity

11-46. INSTALLATION OF WIRES IN CONDUIT.

11-47. CONDUIT CAPACITY. Measure the bundled wires before installing in conduit. In accordance with MIL-W-5088 this diameter must not exceed 80% of the internal diameter of the conduit.

CAUTION

No ties or splices permitted inside a conduit.

11-48. FEEDING WIRES INTO CONDUIT. Feed wires through a short length of conduit by taping the end of the bundle together and pushing it gently through. Longer runs of conduit or conduit with complex bends will require a leader. Make a leader out of a flannel or other soft cloth patch attached to a string long enough to pass completely through the conduit. The patch should fit loosely in conduit. See Figure 11-26. Use compressed air at no more than 35 psi to blow patch and attached string through the conduit. Tie wire bundle securely to string and tape over junction to cover all wire ends. Pull string through conduit while carefully feeding wires into other end. After wire is installed remove tape and detach string.

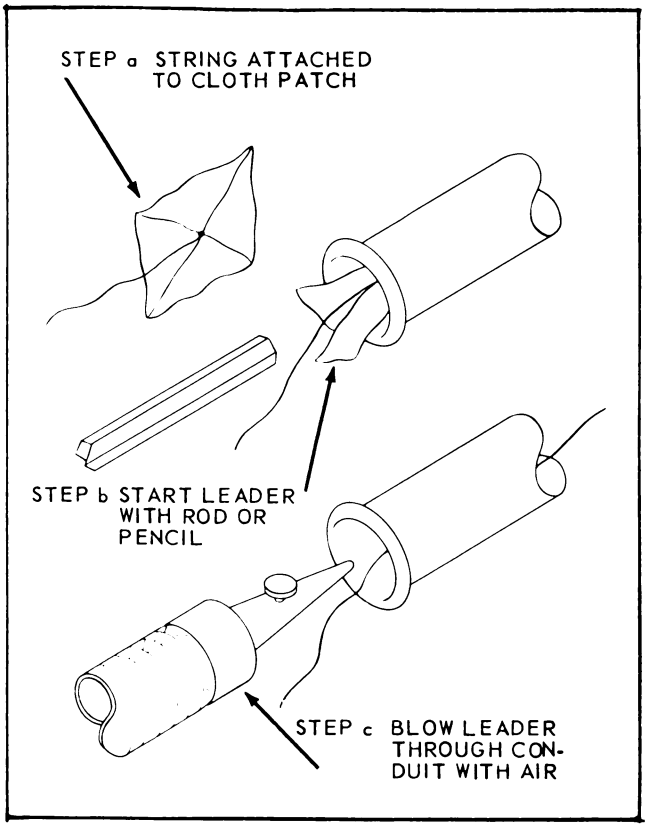


Figure 11-26. Leader for Conduit

11-49. SUPPORTING WIRES AT END OF RIGID CONDUIT. Use a cable clamp, MS-21919, to support wires at each end of conduit. Place the cable clamp in a direct line with the conduit end to prevent chafing of wires at edge of conduit. Place cable clamp as close at end of conduit as practicable, but never more than 10 inches away. See Figure 11-27.

NOTE

Do not leave wire slack inside conduit. Wires should be free, not taut, inside conduit.

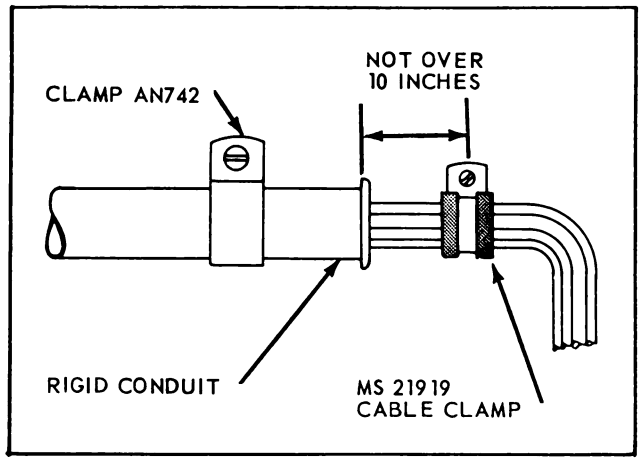


Figure 11–27. Support for Wire at Conduit End

11–50. INSTALLATION OF CONNECTORS.

11–51. ASSEMBLY OF CONNECTORS TO RECEPTACLES. Assemble connectors to receptacles as follows:

CAUTION

Do not use force to mate connectors to receptacles.

a. Locate the proper position of the plug in relation to the receptacle by aligning the key of one part with the groove or keyway of the other part.

b. Start the plug into the receptacle with a light forward pressure and engage the threads of coupling ring and receptacle.

c. Alternately push in the plug and tighten the coupling ring until the plug is completely seated.

CAUTION

Do not hammer a plug into its receptacle. *Never* use a torque wrench, or pliers to lock coupling rings.

d. Use a strap wrench to tighten coupling rings 1/16 to 1/8 turn beyond finger tight if space around connector is too small to obtain a good finger grip.

11–52. DISASSEMBLY OF CONNECTORS FROM RECEPTACLES. Disassemble connectors as follows:

a. Use strap wrench to loosen coupling rings which are too tight to be loosened by hand.

b. Alternately pull on the plug body and unscrew coupling ring until connector is separated.

CAUTION

Do not pull on attached wires.

c. Protect disconnected plugs and receptacles with caps to keep debris from entering and causing faults.

11–53. CODING OF CONNECTORS. As a design objective, receptacles whose plugs are interchangeable are not located in close proximity to each other.

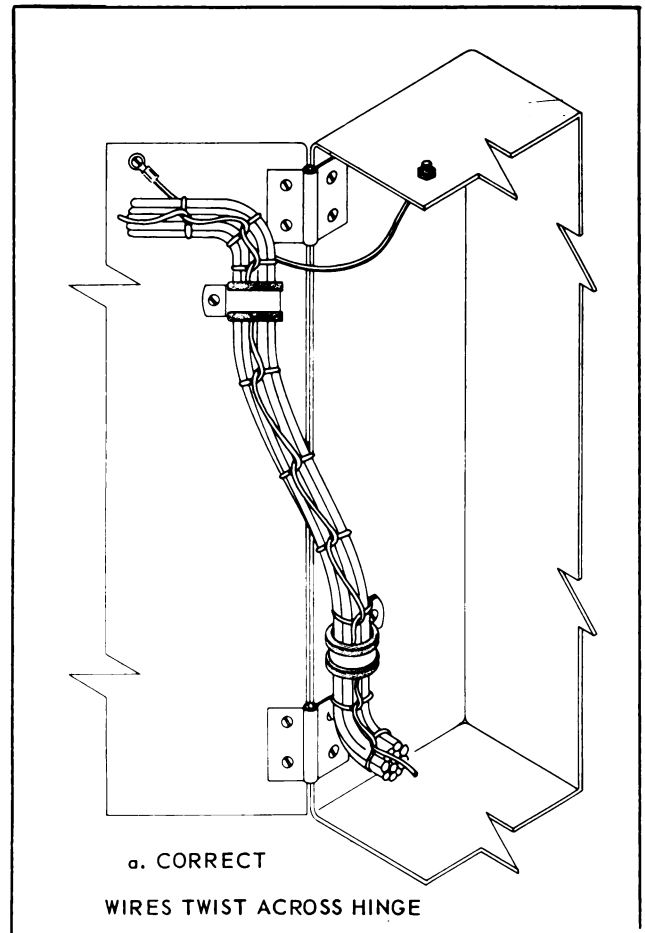


Figure 11–28. Support Inside Junction Box

However, when installation requirements are such that these receptacles are in adjacent locations use clamps on the plug wires, or assemble plugs and receptacles so as to use one of the alternate insert positions, to make it physically impossible to connect a plug into the wrong receptacle. Also color-code the connector plug body and the flange or mounting area of the receptacle.

a. Use one bright color, such as red, green or yellow for each matching pair.

b. Paint only the shell of plugs – not the coupling rings.

c. Paint only the mounting flange of the receptacle.

NOTE

Avoid painting the threaded surfaces or insulators of plugs or receptacles.

11-54. INSTALLATION OF WIRE IN JUNCTION BOXES.

11-55. LACING OR TYING IN JUNCTION BOXES. Wire bundles can be either laced or tied with spot ties. Lacing and tying procedures are described in Section XII.

11-56. SUPPORT INSIDE JUNCTION BOXES. Use MS-21919 cable clamps to support wires across hinged doors so that wires will be twisted and not bent when the door is opened. See Figure 11-28 for correct and incorrect methods of support.

11-57. Attach wire bundles to walls of junction box to prevent chafing or abrasion against terminal studs or other items in box. Tie up slack (required for terminal rework) to prevent snagging.

SECTION XII
LACING AND TYING

12-1. INTRODUCTION.

12-2. GENERAL. Wire groups and bundles are laced or tied with cord to provide ease of installation, maintenance and inspection.

12-3. SCOPE. This section describes and illustrates recommended procedures for lacing and tying wires with knots which will hold tightly under all conditions.

12-4. DEFINITIONS.

a. *Tying* is the securing together of a group or bundle of wires by means of individual pieces of cord tied around the group or bundle at regular intervals.

b. *Lacing* is the securing together of a group or bundle of wires inside enclosures, by means of a continuous piece of cord forming loops at regular intervals around the group or bundle.

c. A *Wire Group* is two or more wires tied or laced together to give identity to an individual system.

d. A *Wire Bundle* is two or more wires or groups tied or laced together to facilitate maintenance.

12-5. REFERENCE SPECIFICATIONS.

MIL-S-572	Synthetic Fiber; Organic; Cords, Yarns, and Mono-filaments
JAN-T-713	Twine, Lacing and Tying, Electrical and Electronic Equipment
MIL-W-5088	Wiring, Aircraft, Installation of
MIL-C-5649	Cord, Cotton, Braided, Prewaxed Insulation
MIL-I-7798	Tape, Electrical, Pressure-Sensitive Adhesive, Plastic

12-6. MATERIALS. Use cotton, nylon or fiber-glass cord for lacing or tying. Cotton cord must have been waxed to make it moisture and fungus resisting. Nylon and fiber-glass cords are in themselves moisture and fungus resisting, and are not usually waxed. Use pressure sensitive vinyl electrical tape only where the use of tape instead of cord is specifically permitted by engineering.

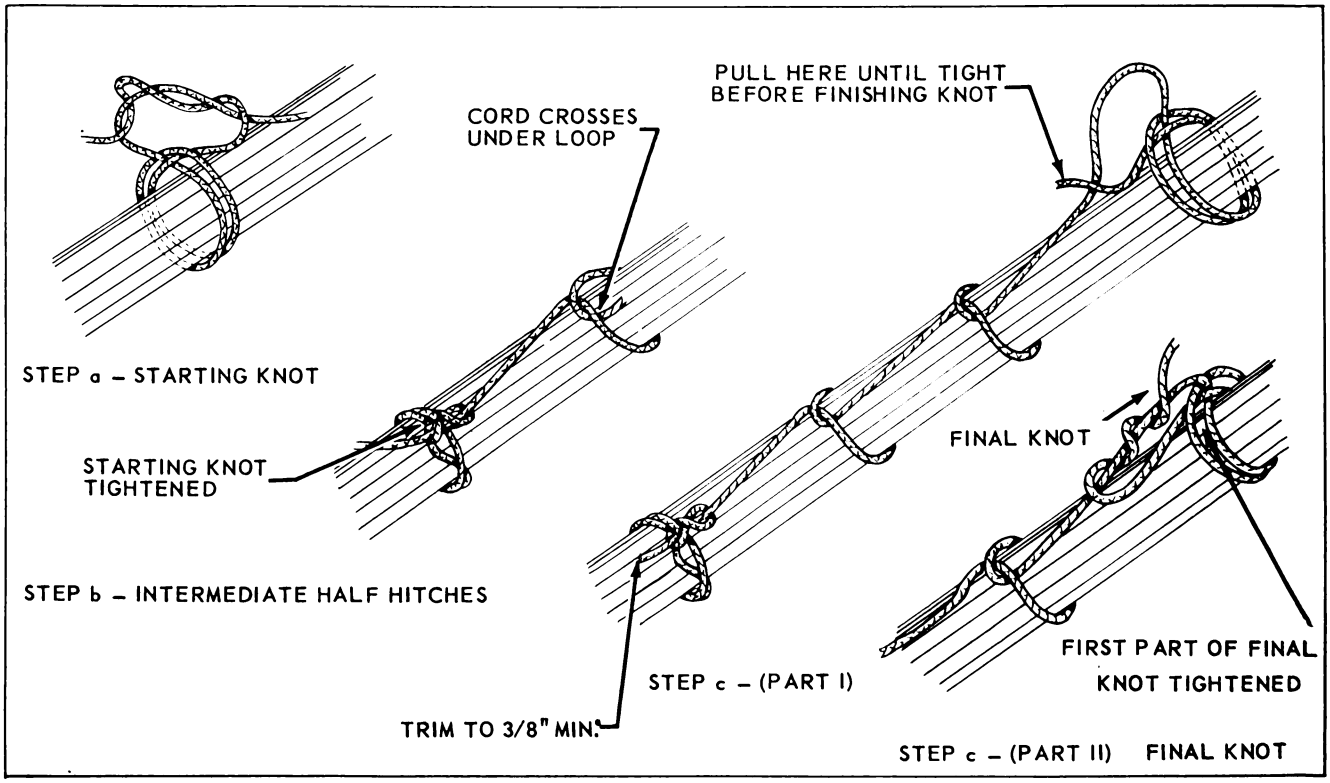


Figure 12–1. Single Cord Lacing

12-7. PRECAUTIONS FOR LACING AND TYING. When lacing or tying, observe the following precautions:

a. Lace or tie bundles tightly enough to prevent slipping, but not so tightly that the cord cuts into or deforms the insulation. This applies especially to coaxial cable, which has a soft dielectric insulation between the inner and outer conductor.

b. Do not place ties on that part of a wire group or bundle that is located inside a conduit.

12-8. LACING. Lace wire groups or bundles only inside enclosures, such as junction boxes. Use double cord on groups or bundles larger than one inch in diameter. Use single or double cord for groups or bundles one inch or less in diameter. For lacing groups which branch off a main bundle, see paragraph 12-10.

NOTE

While lacing, observe the precautions outlined in paragraph 12-7.

12-9. SINGLE CORD LACING. Lace a wire group or bundle with a single cord as follows: (See Figure 12-1)

Step a. Start the lacing at the thick end of the wire group or bundle with a knot consisting of a clove hitch with an extra loop.

Step b. At regular intervals along the wire group or bundle, and at each point where a wire or wire group branches off, continue the lacing with half hitches.

NOTE

Space half hitches so that the group or bundle is neat and securely held.

Step c. End the lacing with a knot consisting of a clove hitch with an extra loop.

Step d. Trim the free ends of the lacing cord to 3/8 inch minimum.

12-10. DOUBLE CORD LACING. Lace a wire group or bundle with a double cord as follows: (Figure 12-2)

Step a. Start the lacing at the thick end of the wire group or bundle with a bowline on a bight.

Step b. At regular intervals along the wire group or bundle, and at each point where a wire group branches off, continue the lacing with half hitches, holding both cords together.

NOTE

Space half hitches so that the group or bundle is neat and securely held.

Step c. End the lacing with a knot consisting of a half hitch, using one cord clockwise and the other counterclockwise, and then tying the cord ends with a square knot.

Step d. Trim the free ends of the lacing cord to 3/8 inch minimum.

12-11. LACING BRANCH-OFFS. Lace a wire group that branches off the main wire bundle as follows: (See Figure 12-3)

Step a. Start the branch-off lacing with a starting knot located on the main bundle just past the branch-off point. When single cord lacing is used, make this starting knot as described in paragraph 12-9, step a; and when double lacing is used, make it as described in paragraph 12-10, step a.

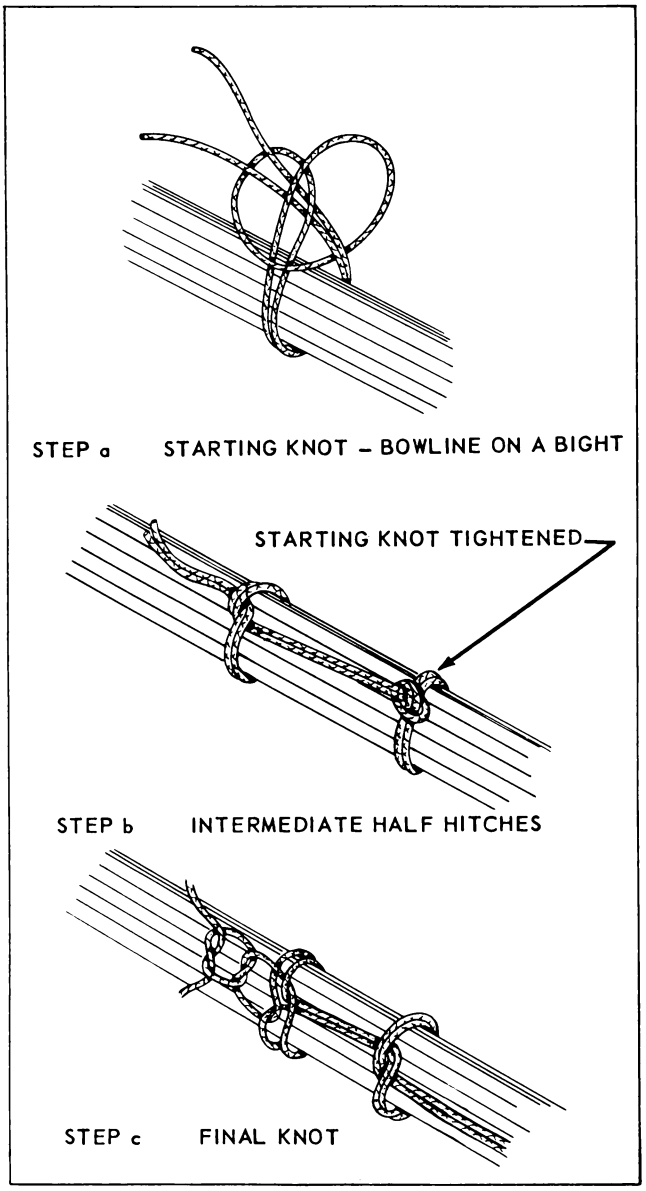


Figure 12-2. Double Cord Lacing

Step b. Continue the lacing along the branched-off wire group, using regularly spaced half hitches. Where a double cord is used, both cords are held together.

NOTE

Space half hitches so that the group or bundle is neat and securely held.

Step c. End the lacing with the regular knot used in single and double cord lacing, as described in paragraphs 12-9, step c, and 12-10, step c, respectively.

Step d. Trim the free ends of the lacing cord to 3/8 inch minimum.

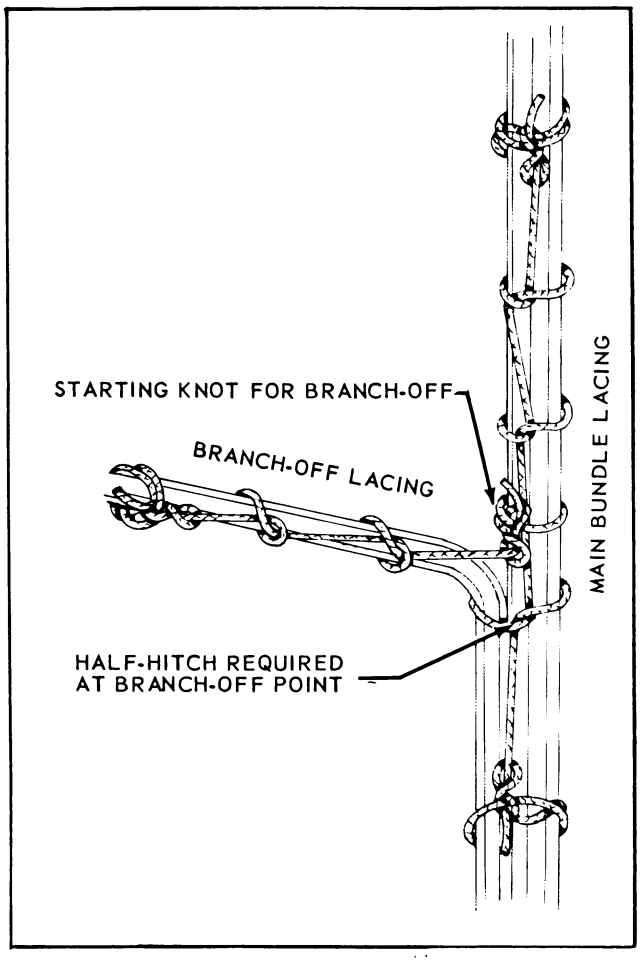


Figure 12–3. Lacing a Branch-off

12-12. TYING. Tie all wire groups or bundles where supports are more than 12 inches apart. Space ties 12 inches or less, apart.

12-13. MAKING TIES. See Figure 12-4. Make tie as follows:

a. Wrap cord around wire group or bundle, as shown in Figure 12-4.

b. Make a clove hitch, followed by a square knot with an extra loop.

c. Trim free ends of cord to 3/8 inch minimum.

12-14. TEMPORARY TIES. Temporary ties are used to aid in making up and installing wire groups or bundles. Use colored cord to make temporary ties, and remove such ties when the installation is complete.

CAUTION

Cut temporary ties with scissors or diagonal pliers only. Do not use a knife or other sharp edged instrument which may damage the insulation.

12-15. TYING WIRE GROUPS INTO WIRE BUNDLES. Tie wire groups into bundles as described in paragraph 12-13, treating the wire groups as though they were individual wires.

12-16. TYING SLEEVES TO WIRE GROUPS OR WIRE BUNDLES. Secure sleeves to wire groups or bundles by tying as described in paragraph 12-13.

12-17. SECURING WITH TAPE. See Figure 12-5. When tape is permissible to be used, the following method should be employed:

a. Wrap tape around wire group or bundle three times, with a two-thirds overlap for each turn.

b. Heat-seal the loose tape end with the side of a soldering iron heating element.

CAUTION

Do not use tape for securing wire groups or bundles which may require frequent maintenance.

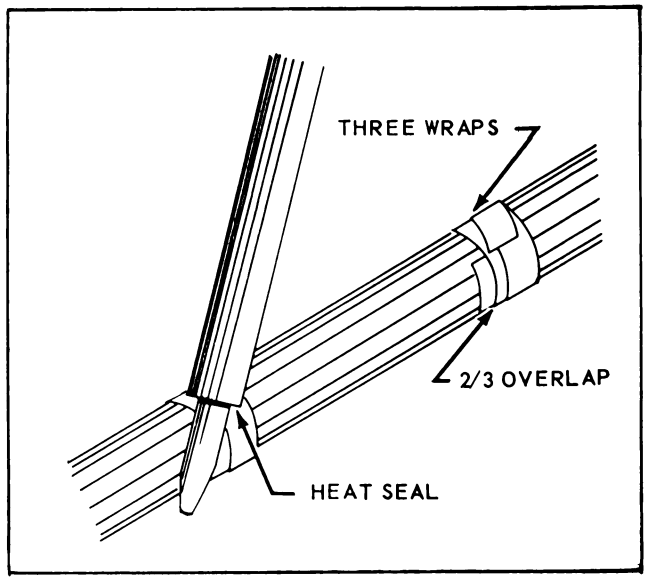


Figure 12–5. Tying with Tape

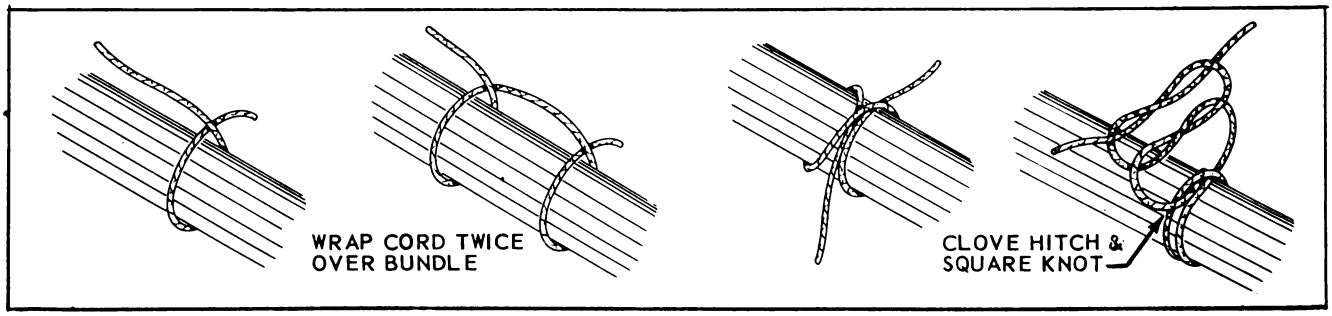


Figure 12–4. Making Ties

SECTION XIII
SAFETY WIRING

13-1. INTRODUCTION.

13-2. GENERAL. Electric connectors, emergency devices and other pieces of electric equipment in aircraft are secured with safety wire when specified on engineering drawings in order to prevent accidental loosening.

13-3. SCOPE. This section outlines the recommended procedures for safety wiring AN electric connectors, and emergency devices such as switches, switch guards and handles which operate ejection seats, emergency bomb releases, fire extinguishers etc. Some general practices for safety wiring are set forth in drawing MS 33540.

13-4. REFERENCE SPECIFICATIONS AND DRAWINGS.

MIL-W-5088	Wiring, Aircraft, Installation of
AN995	Wire-Lock
MS33540	Safety Wiring, General Practices for

13-5. SAFETY WIRE SELECTION.

13-6. MATERIAL. For securing coupling parts of AN connectors, use corrosion resisting steel lock wire. For securing emergency devices, where it is necessary to be able to break safety wire quickly, use aluminum or copper lock wire. In locations where the lock wire may come into contact with magnesium, use zinc coated carbon steel lock wire.

13-7. SIZE. Use .032 inch diameter lock wire wherever possible, except that on small parts with holes .045 inch nominal diameter or smaller, use .020 inch diameter lock wire.

13-8. LENGTH. Use lock wire of the shortest length that will allow accomplishment of procedures outoutlines in paragraphs 13-10 through 13-20.

13-9. GENERAL PROCEDURES FOR SAFETY WIRING.

CAUTION

Use only *new* lock wire; when replacing safety wired electrical connectors or emergency devices, do not attempt to re-use the old lock wire.

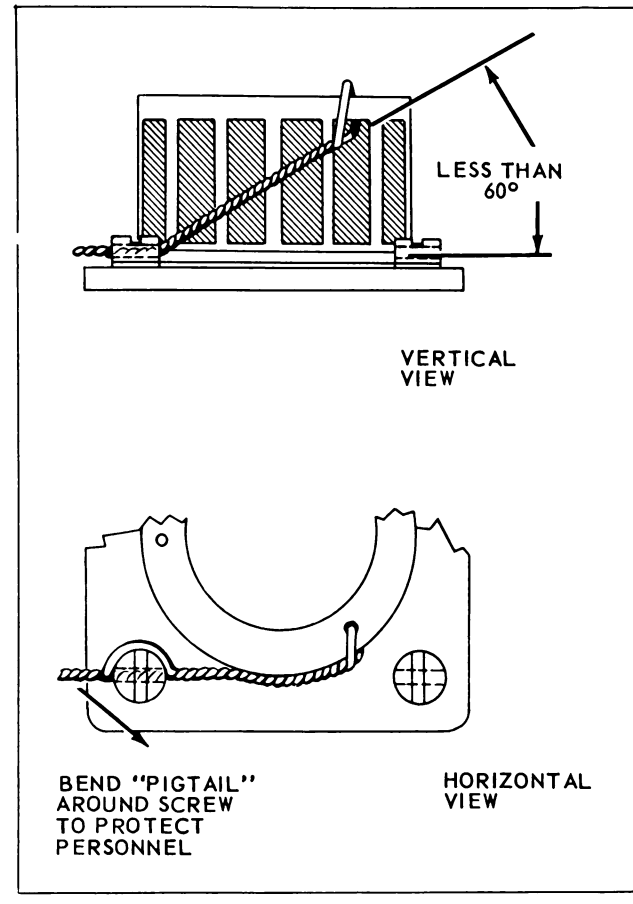


Figure 13-1. Double Twist Safety Wiring

13-10. DOUBLE TWIST SAFETY WIRING. Use the double twist method of safety wiring, as illustrated in Figure 13-1 whenever possible, except as noted in paragraph 13-11.

13-11. SINGLE WIRE METHOD. When necessary, use single wire method of safety wiring as illustrated in Figure 13-2, in the following cases:

a. For all emergency devices.
b. For safety wiring in areas difficult to reach.
c. For small screws in a closely spaced pattern, as illustrated in Figure 13-2.

13-12. TWISTING WITH PLIERS. When lock wire is twisted by hand, use pliers for the final twists to apply tension, and to secure ends of wire. Cut off part of wire gripped by pliers to remove rough edges.

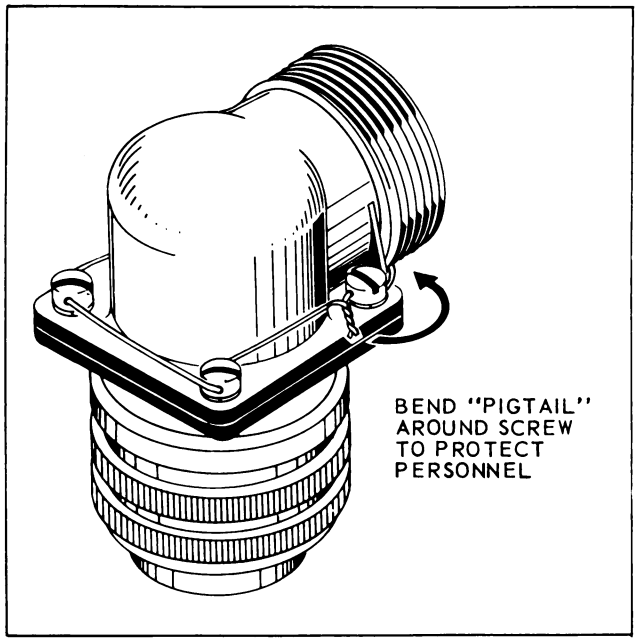


Figure 13–2. Single Wire Method

CAUTION

Make sure lock wire does not become kinked or nicked during twisting operation, and that plating on zinc coated wire is not damaged. If wire is damaged replace with new lock wire.

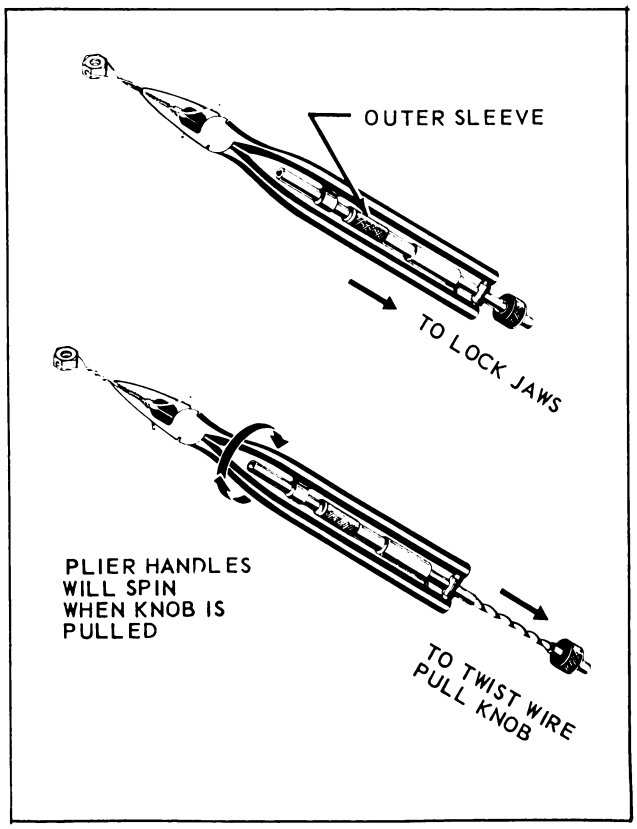


Figure 13–3. Use of Wire Twister

13-13. TWISTING WITH SPECIAL TOOLS. Twist lock wire with a wire twister as follows: See Figure 13-3.

a. Grip wire in jaws of wire twister and slide outer sleeve down with thumb to lock handles.

b. Pull knob; spiral rod spins pliers and twists the wire.

c. Squeeze handles together to release wire.

13-14. TIGHTNESS OF WIRE. Install lock wire so that the wire will be in tension if the part loosens. Twist lock wire together so that it is tight, but do not overstress wire as it may break under load or vibration.

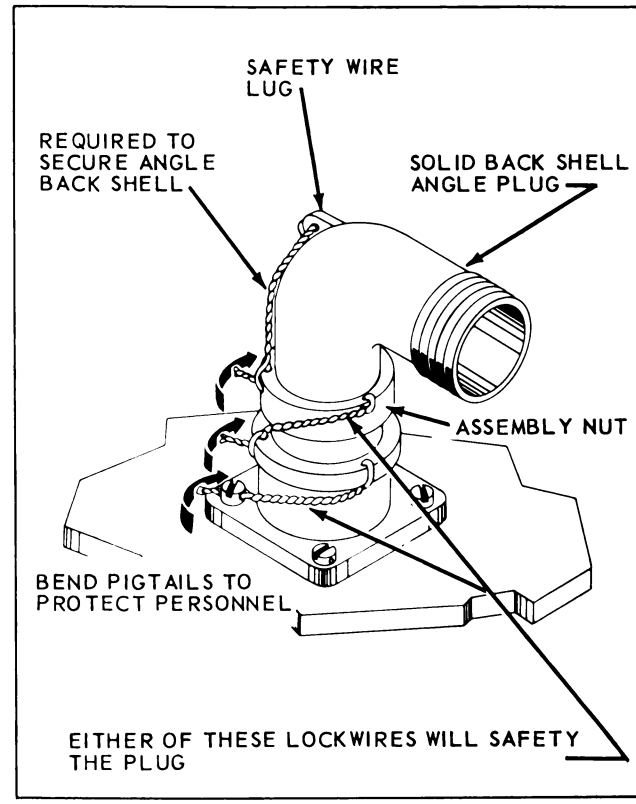


Figure 13–4. Safety Wiring AN Connectors

13-15. SPECIFIC PROCEDURES.

13-16. SAFETY WIRING ELECTRICAL CONNECTORS. Secure electric connectors with lock wire only when specified on engineering drawings. Electric connectors are usually safely wired in engine nacelles, areas of high vibration and in locations not readily accessible for periodic maintenance inspection.

13-17. SAFETY WIRING AN CONNECTORS. When specified on engineering drawings, safety-wire AN connectors as follows: See Figure 13-4.

a. Thread lock wire through wire hole in coupling ring.

NOTE

If connector plug to be safety wired does not have a wire hole, remove coupling nut and drill a #56 (.046) diameter hole diagonally through the edge of nut, as shown in Figure 13-5.

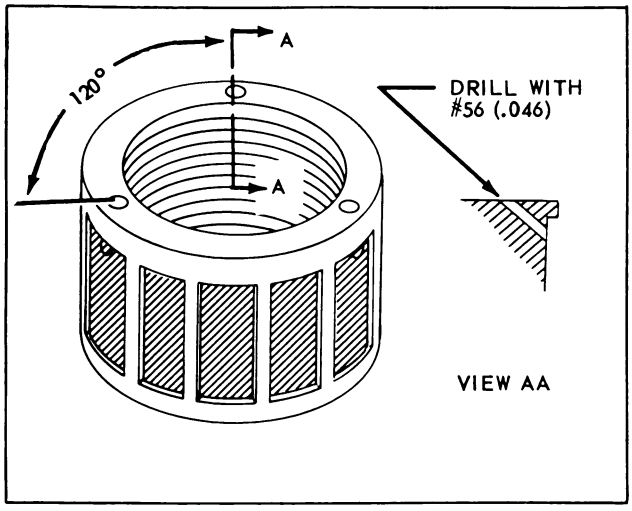


Figure 13–5. Drilling Holes in Coupling Nut

b. Twist wire, under slight tension, approximately 6 to 8 turns per inch, by hand, or by special tool, as described in paragraphs 13-12 and 13-13. Twist wire right handed, so it will have a tightening effect.

c. Pull one end of twisted wire through hole in drilled fillister head screw on mounting flange of connector. Use a fillister head screw so located as to allow a 60° or smaller angle of the wire, as shown in Figure 13-1.

CAUTION

Do not "back off" or over-torque mounting fillister head screws, in order to align holes for safety wiring.

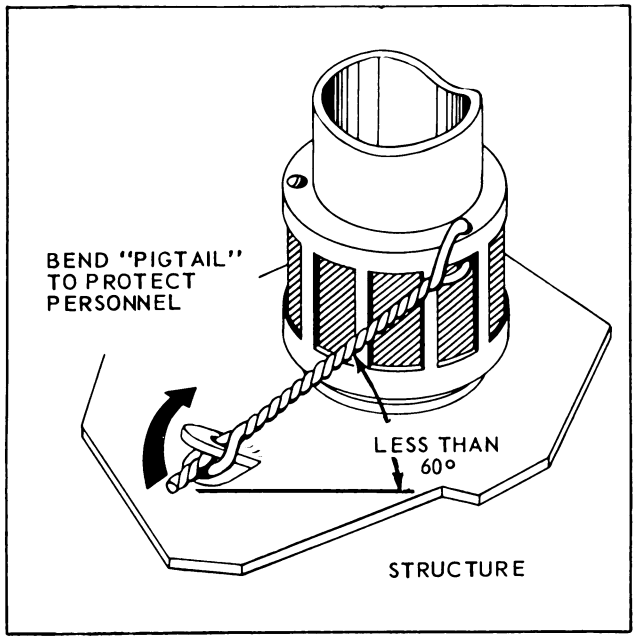


Figure 13–6. Safety Wiring "AN" Connector to Structure

d. Form "pigtail" 1/4 to 1/2 inch (3 to 6 twists) with pliers.

e. Bend "pigtail" back toward body of connector, to prevent it from injuring personnel.

CAUTION

Safety wire all connectors individually. Do not secure one connector to another.

13-18. SAFETY WIRING CONNECTOR TO STRUCTURE. If no screw is available for attaching lock wire, secure wire to drilled hole in structure not more than 6 inches from connector, as shown in Figure 13-6. Use same procedure as described in paragraph 13-17.

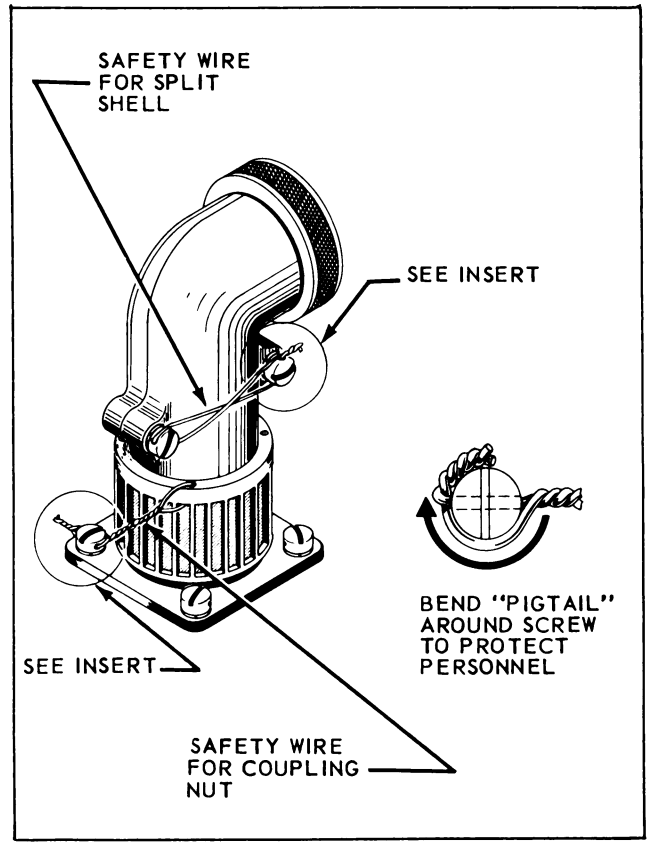


Figure 13–7. Safety Wiring "AN" Split Shell Assembly Screws

13-19. SAFETY WIRING SPLIT SHELL ASSEMBLIES. Split shell connectors made by Amphenol are held together by two fillister head screws. Secure these screws as follows: (See Figure 13-7)

a. Draw wire through hole in one screw.

b. Cross wire from left to right between screws, and draw through second screw.

c. Twist wires together with pliers, and bend back.

13-20. SAFETY WIRING SOLID SHELL ANGLE PLUGS. Angle plugs with solid back shells as made by Amphenol are in two parts, held together by four screws through mating flanges. Safety wire these screws with a single wire as shown in Figure 13-2.

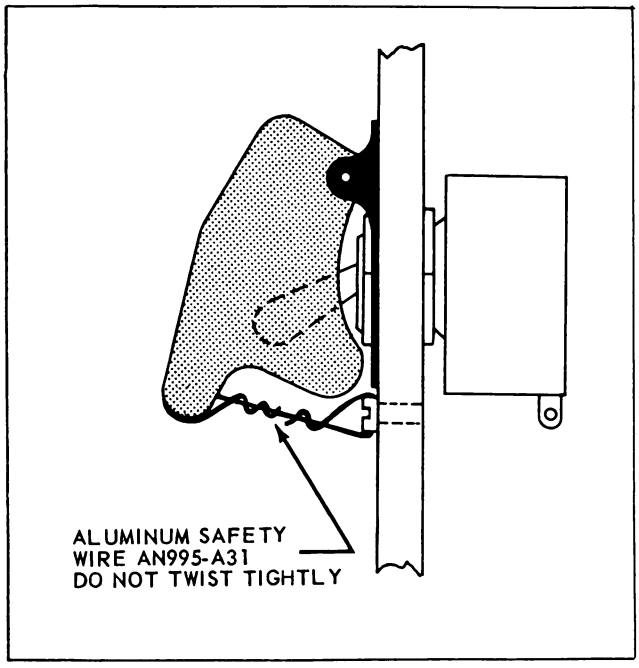


Figure 13–8. Safety Wiring Switch Guard

Solid shell angle plugs made by Bendix and Cannon have back shells held in place by assembly nuts. Install a double twisted lock wire between hole in assembly nut and lug on back shell as shown in Figure 13-4. If necessary to safety the plug itself, install a second double twisted wire between the assembly nut and the coupling nut or between the coupling nut and one of the receptacles mounting screws, as shown in Figure 13-4.

13-21. SAFETY WIRING EMERGENCY DEVICES. Use single wire method to secure emergency devices. Make sure that wire is so installed that it can easily be broken when required in an emergency situation. See Figure 13-8.

SECTION XIV
EMERGENCY REPAIRS

14-1. INTRODUCTION. This section covers the procedure for making repairs at advance fields where the minimum of tools and equipment are available.

14-2. SCOPE. Covered in this section will be the repairing of damaged or broken copper wires and the repair of connectors.

CAUTION

All repairs described in this section are temporary, for emergency use only. Replace all temporary repairs as soon as possible with permanent repairs.

14-3. REPAIR OF BROKEN WIRES. Repair of broken wires is accomplished by means of crimped permanent splices, by the use of terminal lug from which the tongue has been cut off, or by soldering together the broken strands, and applying potting compound.

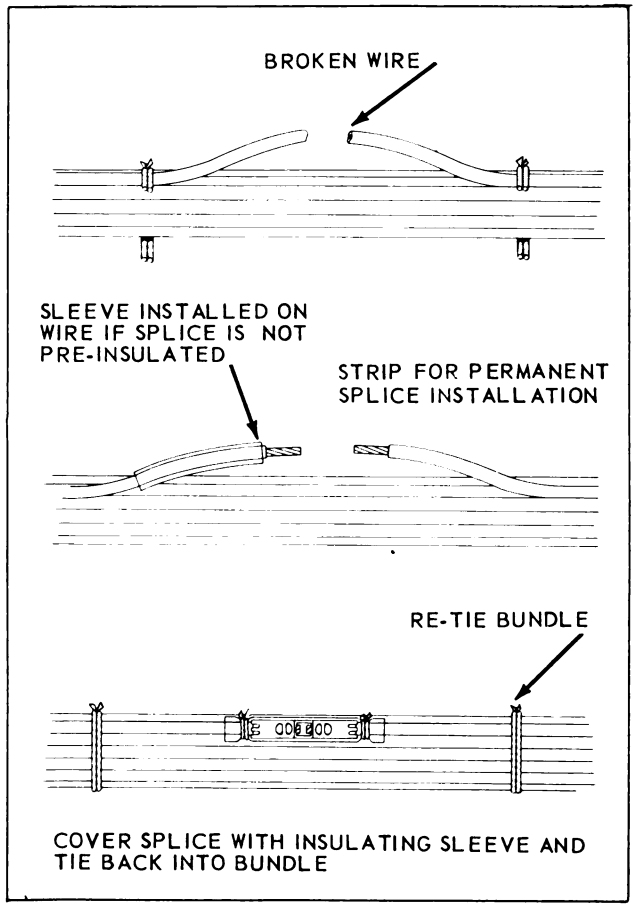


Figure 14-1. Permanent Splice Repair

14-4. SPLICING BROKEN WIRES WITH PERMANENT SPLICE. See Figure 14-1. When splicing wires by means of permanent splices observe the following procedures.

NOTE

Do not splice aluminum wires. Damaged aluminum wire must be replaced.

a. Cut ties and work the broken wire to the outside of the bundle.

b. Pull sufficient slack from the wire run toward the splice so that there will be no strain on the splice.

c. Trim the wire as close to the break as possible so that all strands will be of equal length.

d. Clean the wire for a distance of at least 1 inch of the break with Stoddard's Solvent. This will insure the removal of foreign particles and debris to provide a good insulating surface.

e. Slide a piece of flexible transparent tubing slightly larger in diameter than the O.D. of the splice being used over one end of the severed wire.

f. Install the splice as described in Section V paragraphs 5-52 through 5-59, and re-tie spliced wire into bundle.

14-5. SPLICING WITH TERMINAL LUG BARREL. When a permanent splice is not available, the barrel of a terminal lug can be used.

a. Select a terminal lug with a barrel large enough to accomodate both wires.

b. Cut off the terminal lug tongue.

c. Prepare the wires as described in paragraph 14-4.

d. Insert the wires from opposite ends of the barrel so that each wire protrudes thru the barrel 1/32 inch.

e. Crimp the barrel in the center following the procedures of Section V. (See Figure 14-2).

f. Slide the sleeving down over the connection so that it extends about 1/2 inch past each end of the crimped barrel and then tie it with nylon cord at each end.

14-6. SPLICING WITH SOLDER AND POTTING COMPOUND.

When neither a permanent splice nor a terminal lug is available repair a broken wire as follows: (See Figure 14-3).

a. Install a piece of plastic sleeving about 3 inches long, and of the proper diameter to fit loosely over the insulation, on one piece of the broken wire.

b. Strip approximately 1 1/2 inches from each broken end of wire.

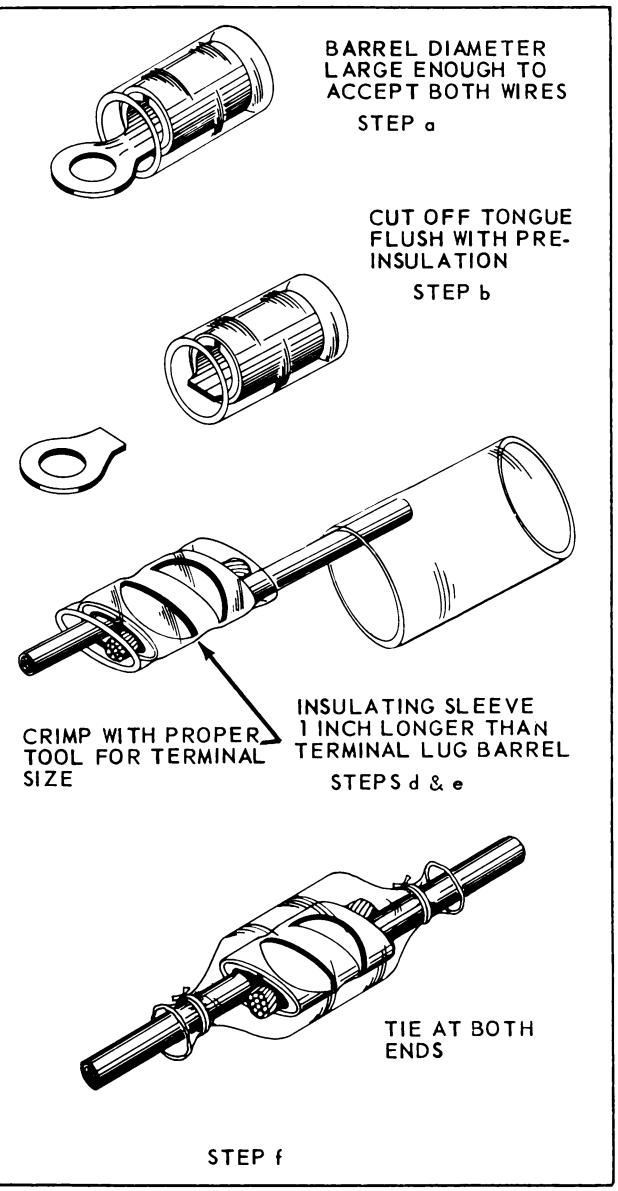


Figure 14-2. Terminal Lug Barrel Repair

c. Lay the stripped ends side by side and twist one wire around the other with approximately four turns.

d. Twist free end of second wire around first wire with approximately four turns. Solder wire turns together, using 60/40 tin-lead rosin core solder.

e. When solder is cool, draw sleeve over soldered wires and tie at one end. If potting compound is available, fill sleeve with material prepared in accordance with Section III, and tie securely.

f. Allow potting compound to set without touching for 4 hours. Full cure and electrical characteristics are achieved in 24 hours.

14-7. REPAIRING DAMAGED WIRE INSULATION. If the wire insulation is damaged but the wire itself is not damaged, repair the insulation in either of the following ways:

a. Dip the damaged portion of the wire insulation into a container of potting compound. Instructions for mixing potting compound are given in Section III. Allow potting compound to dry in air (70°-75°F) for 4 hours before touching. Full cure and electrical characteristics are achieved in 24 hours.

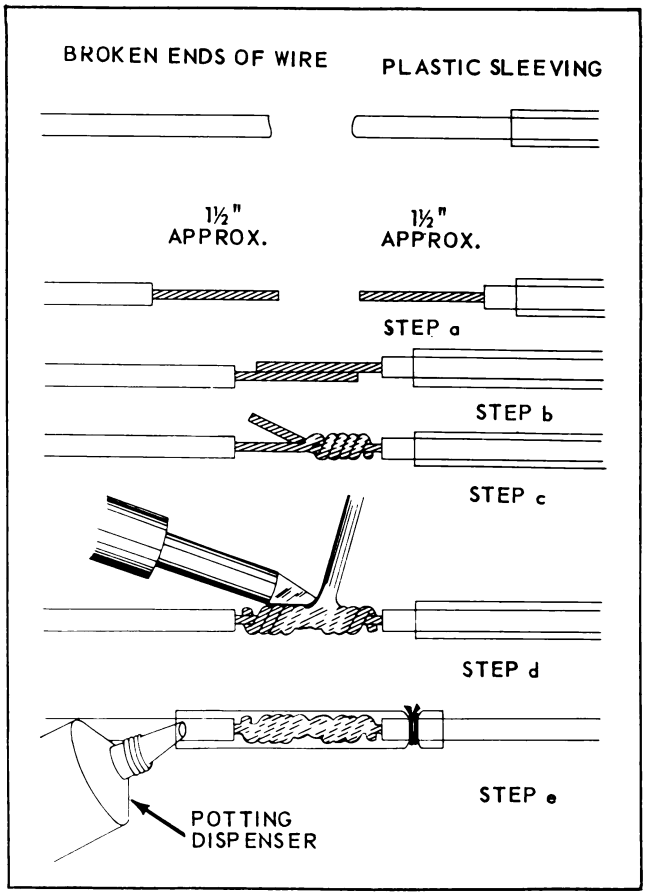


Figure 14-3. Repairing Broken Wire by Soldering and Potting

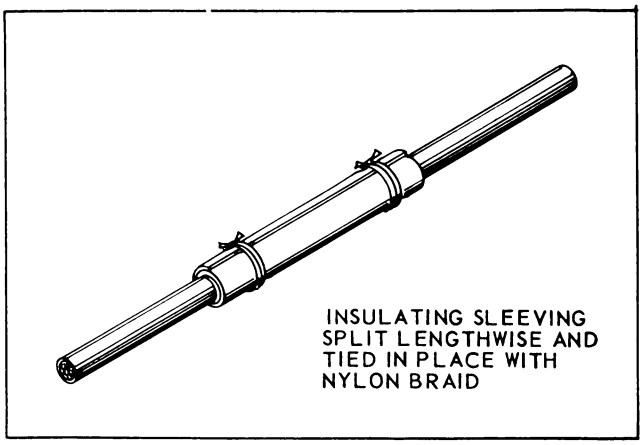


Figure 14-4. Insulation Repair with Sleeving

b. If potting compound is not available, repair damaged wire insulation by using a transparent sleeve of flexible tubing 1 1/2 times the outside diameter of the wire and 2 inches longer than the damaged portion of the insulation. This sleeving is split lengthwise and wrapped 1 1/2 times around the wire at the dam-

aged section. Tie with nylon braid at each end and at 1 inch intervals over the entire length. See Figure 14-4.

14-8. REPAIRING SHIELDED CABLE. When shielded cable is severed it can be repaired in the following manner: See Figure 14-5.

a. Prepare the severed ends of the cable for application of a grounding sheath connector per Section II, paragraph 2-57, steps a and b.

b. Select a grounding sheath per Section II, paragraphs 2-57, steps c, d and e.

c. Slide two insulating sleeves, the inner one just large enough to pass over the grounding sheath connector, and the outer one large enough to accomodate the inner insulating sleeve and the grounding lead. The inner insulating sleeve should be just long enough to completely cover the permanent splice. The outer sleeve must be long enough to extend beyond the two grounding sheath connectors as shown in Figure 14-5.

d. Attach a grounding sheath connector to one end of the severed wire per Section II, paragraph 2-57, steps f through j. The grounding wire should be long enough to span the repair.

e. Install the inner and outer barrel of a grounding sheath connector on the other side of the break. Do not crimp this yet.

f. Use a permanent splice to join the severed inner conductor, or use the barrel of a terminal lug when a permanent splice is not available. See paragraph 14-5.

g. Slide inner insulating sleeve into position as shown in Figure 14-5.

h. Push the free end of the grounding wire from step c, above, into the uncrimped grounding sheath connector. Crimp securely.

i. Slide outer insulating sleeve into place and tie both ends with nylon braid as shown.

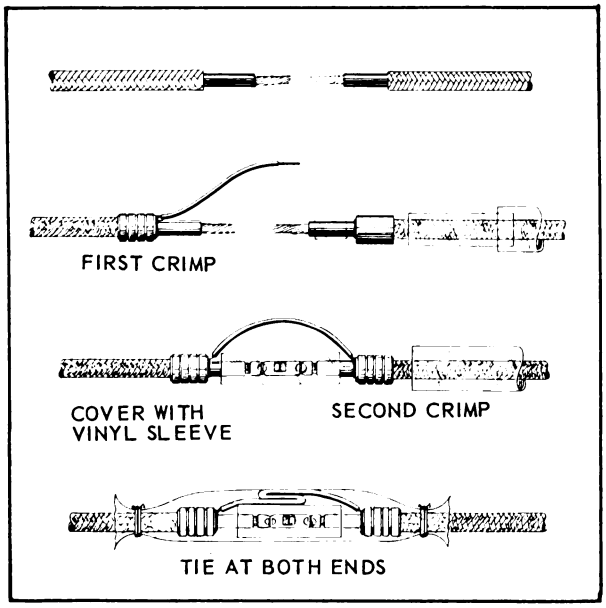


Figure 14–5. Repair of Shielded Wire

14-9. An alternating method of repairing shielded cable is to be used if grounding sheath connectors as described in paragraph 14-8 are not available. The alternate method shown in Figure 14-6 is as follows:

a. Prepare the severed ends of the cable for pigtail method of shield termination as described in Section II, paragraph 2-58, steps a through d.

b.. Use pre-insulated splice connector to join inner conductors as described in Section V, paragraph 5-55.

c. Use two splice connectors to add short length of insulated wire as extension to complete shield connection.

14-10. REPAIRING DAMAGED SHIELDING. When the shielding braid of shielded cable has been damaged, cut the cable sharp and square, and repair as described in paragraphs 14-8 or 14-9.

CAUTION

Do not attempt to repair damaged shielding braid by covering with tape, as it is not possible to seal off severed ends, and these may puncture the wire insulation.

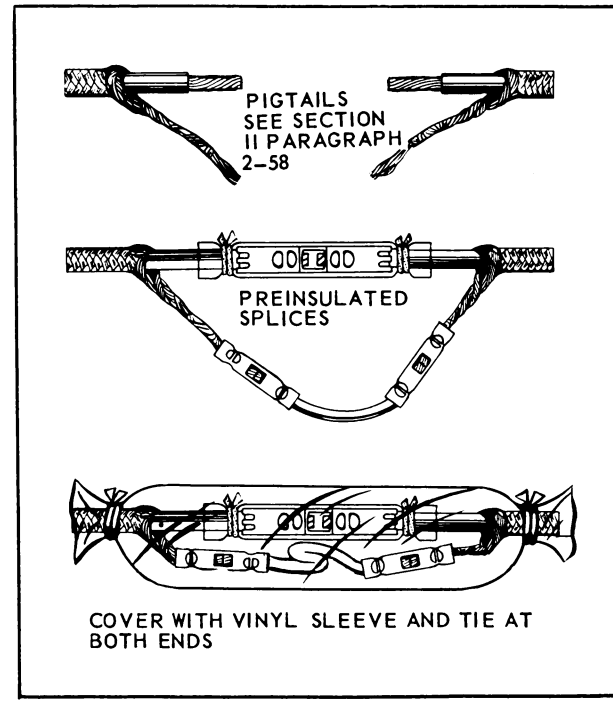


Figure 14–6. Alternate Repair of Shielded Wire

14-11. REPAIRING COAXIAL CABLE. Do not attempt to patch up broken or damaged coaxial cable. If possible replace the entire cable. If this is not possible, install a matching plug and jack of the proper size and type at the broken or damaged part, using the procedures described in Section IV.

CAUTION

As every extra connection in a coaxial cable means a loss in efficiency, replace repaired coaxial cables at the earliest possible time.

14-12. REPAIRING DAMAGED AN CONNECTORS. Defective AN Connectors which have broken pins can be temporarily repaired in the following manner:

a. Where it is possible to get at both halves of the connector one of the spare wires provided may be used by splicing the wire from the damaged or broken pin to the spare wire following the procedures of Section V, paragraphs 5-52 through 5-59. This procedure must be done to the wire leading to both halves of the connector. The unit must then be marked that this repair has been done. Replace both altered connectors at the next major overhaul of the aircraft.

14-13. REPAIRING POTTED CONNECTORS. Potted connectors should have been equipped with spare wires on all spare pins. If a pin becomes defective the repair is made by cutting the wire leading to the defective pin and using a permanent splice (as previously described) to join the wire to a spare wire. The mating connector must also be so modified.

CAUTION

Tag both connector halves with complete information on the modification. Replace both connector halves at the earliest opportunity.

If a spare wire is not available, it is possible to replace pins in potted *resilient* connectors which do *not* have metallic back shells. The following procedure should be carefully followed:

a. Cut away the potting compound (sealant) with a thin knife blade or scalpel. Use long nose pliers to pull the sealant while cutting. Be careful not to cut into wire insulation.

b. Carefully scrape away sealant from defective pin.

c. Use a small (pencil) soldering iron or a soldering gun to unsolder the wire lead from pin.

d. Use long nose pliers to pull pin out of resilient insert.

e. Solder wire to new pin and push pin into insert from rear.

f. Pour new potting compound into area of repair and air cure at room temperature for 24 hours. The new compound will seal satisfactorily to any old compound remaining in connector.

Occasionally a wire will fail inside the potted area of a connector. If this occurs follow the same steps as described above to reach the soldered connection. Do not remove the pin, but solder the new wire to the pin and then repot the connector.

14-14. REPLACING DAMAGED OR LOST TERMINAL STRIP COVERS. When a terminal strip cover is lost or damaged so as to be unuseable, cover the strip temporarily with a piece of large vinyl tubing, split lengthwise, and tied securely around the terminal strip. This procedure is described in Section X, paragraph 10–44 and shown in Figure 10-12.

CAUTION

All repairs described in this section are temporary, for emergency use only. Replace all temporary repairs as soon as possible with permanent repairs.

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price $1.25

* U. S. GOVERNMENT PRINTING OFFICE : 1957 O—441848